

EXHIBIT A

OPTN/SRTR 2016 Annual Data Report: Liver

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Abstract

Data on adult liver transplants performed in the US in 2016 are notable for (1) the largest total number of transplants performed (7841); (2) the shortest median waiting time in recent history (11.3 months); (3) continued reduction in waitlist registrations and transplants for hepatitis C-related indications; (4) increasing numbers of patients whose clinical profiles are consistent with non-alcoholic fatty liver disease; and (5) equilibration of transplant rates in patients with and without hepatocellular carcinoma. Despite the increase in the number of available organs, waitlist mortality remained an important concern. Graft survival rates continued to improve. In 2016, 723 new active candidates were added to the pediatric liver transplant waiting list, down from a peak of 826 in 2005.

The number of prevalent candidates (on the list on December 31 of the given year) was stable, 408 active and 169 inactive. The number of pediatric living donor liver transplants decreased from a peak of 79 in 2015 to 62 in 2016, with most from donors closely related to the recipients. Graft survival continued to improve over the past decade among recipients of deceased donor and living donor livers.

Keywords: Liver transplant, allocation, distribution, waiting list.

1 Adult Liver Transplant

1.1 Summary

The total number of adult liver transplants continued to increase in 2016, reaching 7841, a 10% increase over 2015. The increase was attributable to more deceased donors, positively affecting median waiting time, which decreased to 11.3 months.

In 2016, the number of candidates added to the liver transplant waiting list continued to increase (11,340, compared with 10,636 in 2015). As of December 31, 2016, 13,726 candidates (11,140 active) were waiting for an organ, 2% less than in 2015.

Of adult waitlist registrants in 2013, the 3-year cumulative incidence of transplant was 55%. Transplant rates were substantially affected by geography; percentages of patients undergoing transplant within 3 years varied from 29% to 86%.

In addition to more transplants, a few trends were notable in 2016. First, antiviral therapy for hepatitis C virus (HCV) likely had important effects on liver transplant, as did declining prevalence of HCV infection in people aged 18-65 years. Waitlist registrations and transplants for candidates with HCV continued to decrease sharply. The discard rate of HCV-positive donor organs was reduced to a level similar to that for HCV-negative organs. Second, the clinical profile for increasing numbers of liver transplant candidates was consistent with non-alcoholic fatty liver disease. Third, the transplant rate for patients with hepatocellular carcinoma (HCC) decreased and the rate for non-HCC patients increased, such that in 2016 the two became closer than ever before.

Liver transplant outcomes continued to improve, with the incidence of graft failure at 1 year decreasing to 9.8% for recipients of deceased donor livers. The 5-year survival rate for recipients of living donor livers in 2008-2011 was 74.6%. As of June 30, 2016, nearly 80,000 adults were living with a functioning liver graft.

1.2 Waiting List Registration

The number of candidates added to the liver transplant waiting list increased in 2016 to 11,340, compared with 10,636 in 2015 and 10,646 in 2014 (Figure LI 1). In contrast, the number of candidates waiting at the end of the year decreased compared with 2015 (13,726 versus 14,052; Figure LI 2), continuing a downward trend since the peak (15,366) in 2011. The dichotomous trends between incident (i.e., new patients) and prevalent (i.e., currently waiting) candidates may be at least in part explained by increased numbers of transplants.

The age distribution of adults waiting for liver transplant (Figure LI 3) shows that the proportion of candidates aged ≥ 65 years has been increasing, but the largest group remained those aged 50-64 years in 2016. The proportion of candidates with

HCV continued to decrease sharply (Figure LI 5), whereas proportions of candidates with alcoholic liver disease and “other” diagnosis increased. The latter category likely represents mostly candidates with nonalcoholic fatty liver disease. In 2016, 8.6% of candidates had a primary diagnosis of HCC. Regarding medical urgency, candidates for liver transplant most commonly had model for end-stage liver disease (MELD) scores between 15 and 29 (Figure LI 6). The proportion with MELD scores 30-34 increased from 7.8% in 2015 to 10.5% in 2016 (Figure LI 6). More than one in five candidates (20.7%) in 2016 had a MELD score of ≥ 30 . The trend toward increasing body mass index (BMI) continued (Figure LI 7). Although BMI in end-stage liver disease patients with fluid retention and ascites is not necessarily a reliable indicator of adiposity, 16.5% of candidates were classified as morbidly obese (BMI > 35 kg/m²), including 5% with BMI > 40 kg/m². These data further suggest that in 2016, non-alcoholic fatty liver disease was the leading indication for waitlist registration.

1.3 Waiting List Outcome

Deceased donor liver transplant rates among active adult waitlist candidates of all ages increased in the past 5 years, due in part to increasing numbers of deceased donors. One of the most important trends in 2016 showed a closing gap in transplant rates between HCC and non-HCC candidates (Figure LI 9). This may be attributable to the so-called “Cap and Delay” policy, implemented in October 2015 and designed to bring transplant rates for HCC and non-HCC closer together.

Figure LI 10 shows 3-year outcomes for adults listed for liver transplant in 2013. Over half (55%) underwent liver transplant (including 2% with living donor livers); 13% died and 19% were removed from the list without undergoing transplant. For candidates with MELD ≥ 35 , waiting time decreased from 0.6 months in 2012 to 0.2 months in 2016, consistent with the intent of the regional share 35 policy (Figure LI 11). This was identical to the median waiting time for status 1A candidates. Of note, waiting time for candidates with lower MELD scores also decreased. Similarly, proportions of candidates undergoing deceased donor liver transplant within a given time period after listing trended up in recent years (Figure LI 12). The proportion of candidates undergoing transplant within 3 months was 28% and within 6 months 36% (Figure LI 12). This may be attributable to more available donors and to more candidates being listed with higher MELD scores. Substantial geographic difference in deceased donor transplant rates remained (Figure LI 13); the difference between the highest and lowest transplant rates within 5 years was almost fourfold, 29% vs. 86%.

Generally, waitlist mortality rates for adults decreased in recent years, for all age groups except perhaps for the youngest group, ages 18-34 years (Figure LI 14). Regarding race-specific waitlist mortality rates, the lowest were for Asians (Figure LI 15), which may be partly due to high prevalence of hepatitis B virus infection and HCC. As expected, mortality rates were higher for candidates with acute liver failure than for those with chronic liver disease (Figure LI 16). To appreciate pretransplant mortality for candidates with chronic liver disease and high MELD (≥ 35), contrast Figure LI 16 and Figure LI 17. Mortality for candidates with acute liver failure was 17.6 per 100 waitlist years (Figure LI 16), and for candidates with MELD ≥ 35 , 339.8 per 100 waitlist years, nearly 20-fold higher. Considering deaths shortly after waitlist removal, mortality for these patients would be even higher than for candidates with acute liver failure (Figure LI 19). Although mortality rates for high-MELD candidates decreased substan-

tially over the past decade, the curve seems to have reached a plateau recently, and reducing mortality further remains a challenge for policy makers trying to improve the organ distribution and allocation system.

Waitlist mortality rates varied substantially by geography (Figure LI 18). Mortality did not mirror transplant rates (Figure LI 13), suggesting that waitlist outcomes were determined by factors other than simply organ availability, including referral and waitlist registration practices and possibly pretransplant patient management and quality of care.

1.4 Donation

The trend in donor demographics by age is shown in Figure LI 20. The proportion of donors aged 18-34 years increased noticeably since 2014. The proportion of anoxic deaths continued to increase (Figure LI 28), possibly reflecting increasing deaths from drug overdose due to the opioid epidemic that has become a major health concern in the US. Figure LI 22 illustrates liver donation rates per 1000 deaths (from all causes, age < 70 years) by state for 2013-2015. The difference was more than five-fold between states with the highest and lowest rates. The highest donation rate was 16.3% in Delaware and the lowest 3.2% in Wyoming. The pattern did not appear to be congruent with either transplant rates or waitlist mortality, possibly because the donation rate expressed here was affected by donor recovery practices and by numbers of deaths and proportions of donation-eligible brain deaths among all deaths.

In 2016, 9.0% of organs recovered for transplant were not transplanted, a decrease from 9.6% in 2015. Discard rates were higher for older donors (Figure LI 23), white donors (Figure LI 25), and deceased cardiac donors (Figure LI 26). The discard rate for HCV-positive donors decreased dramatically (Figure LI 27). In fact, as of 2016, HCV-positive organs were no more frequently discarded than HCV-negative organs (9.0% and 8.9%, respectively). Evidently, highly effective antiviral drugs have made more HCV positive organs available.

In 2016, 336 living donor liver transplants were performed. Most (56%) living donors were closely related, although the number of unrelated donors increased (30%; Figure LI 29). Right lobe transplants accounted for 70%, followed by the left lateral segment (15%) and the left lobe (13%; Figure LI 33). Domino whole liver transplants accounted for 2.3%.

1.5 Transplants

The number of adult liver transplants performed in the US in 2016 exceeded the 2015 record by 10%, 7841 and 7127, respectively (Figure LI 36). Almost all (7496) were deceased donor transplants. Numbers of transplant recipients increased in all age groups (Figure LI 37), but most notably in older age groups, 50-64 years and ≥ 65 years. By diagnosis (Figure LI 40), transplants for HCV showed a substantial decrease. As of 2016, HCV was no longer the most common indication; the most common diagnostic categories were other/unknown, most of which are likely non-alcoholic fatty liver disease and alcoholic liver disease. The increase in liver transplants for non-alcoholic fatty liver disease is corroborated by increasing numbers of obese recipients; more than a third (35%) of all adult recipients were obese by BMI criteria, including 14% with BMI ≥ 35 Kg/m² (Figure LI 41).

The predominant immunosuppressive agents used posttransplant were tacrolimus, mycophenolate, and steroids. A small proportion of recipients were reported to be taking a mTOR inhibitor (Figure LI 45) at transplant, which increased to approximately 10% by the end of the first year. Increasing proportions of recipients remained on steroids at 1 year posttransplant in recent years (Figure LI 46). The significance of this trend is uncertain.

Representing one of the more controversial aspects of liver transplantation in the US, there is wide geographic variability in the degree of sickness, based on median MELD scores, in candidates for deceased donor transplants (Figure LI 47). The highest reported median MELD score was 39, in Los Angeles, California (CAOP), and the lowest 20 in Indianapolis, Indiana (INOP). Scores appeared to be largely reciprocal to transplant rates. Annual transplant center volume varied widely (Figure LI 51). Centers at the 95th percentile performed 169 transplants and those at the 5th percentile only three; the national median was 52. In recent years, centers at the 75th and 95th percentiles performed increasing numbers of transplants, suggesting that larger centers were able to utilize the increase in numbers of available donors.

1.6 Outcomes

Graft failure among deceased donor liver transplant recipients continued to decrease in 2016 (Figure LI 53). For the most recent cohort, the 6-month graft failure rate was 7.3% and the 1-year failure rate 9.8%. For living donor recipients, 3- and 5-year graft failure rates seem to have increased slightly (Figure LI 54). The significance of this remains to be determined. Pretransplant factors such as age (Figure LI 55, Figure LI 67), MELD score (Figure LI 57, Figure LI 70), and liver disease diagnosis (Figure LI 56, Figure LI 68) influenced graft and patient survival in expected directions. Introduction of highly effective HCV therapy has not yet led to better outcomes for HCV positive recipients (Figure LI 56).

Many liver transplant recipients enjoy long-term survival. For those who underwent liver transplant in 2008-2011 with a living donor liver, the 5-year patient survival rate was 81.2% (Figure LI 72). As of June 30, 2016, 79,188 liver transplant recipients were alive with a functioning graft, including 68,970 who underwent liver transplant as adults (Figure LI 64).

2 Pediatric Transplant

2.1 Waiting List

In 2016, 723 new active candidates were added to the pediatric liver transplant waiting list (Figure LI 73); very few (17) were added as inactive. The number of prevalent candidates (on the list on December 31 of the given year) was stable, 408 active and 169 inactive (Figure LI 74). Children aged 1-5 years and 11 years or older made up the largest age groups, 30% each, followed by ages younger than 1 year, 22.4%, and 6-10 years, 14.6% (Figure LI 75). White candidates continued to make up the largest racial/ethnic group on the waiting list in 2016 (50.2%), followed by Hispanic (23.5%), black (16.5%), and Asian candidates (7.3%) (Figure LI 76). Most (66.2%) candidates had been waiting for less than 1 year, 11.9% for 1 to less than 2 years, 8.1% for 2 to less than 4 years, and 13.8% for 4 or more years (Figure LI 77). A shift occurred over the

past decade with dramatically more candidates listed with MELD/pediatric end-stage liver disease (PELD) scores above 35 (17.5% in 2016 vs. 6.4% in 2006), many of whom received MELD/PELD exception scores. More candidates were listed as status 1A/1B (26.6% in 2016 vs. 16.7% in 2006), and fewer were listed with MELD/PELD scores below 15 (16.2% in 2016 vs. 24.4% in 2006) or as inactive (12.6% in 2016 vs. 23.6% in 2006) (Figure LI 78).

Comparing pediatric liver waitlist candidates from 2006 to 2016 shows little change in age, sex, or race (Table LI 13). The most common primary diagnosis reported remained cholestatic biliary atresia (31.1%) in 2016 (Table LI 14). The proportion of candidates with metabolic disease increased from 8.2% in 2006 to 14.6% in 2016. Waiting time shifted such that 55.9% of candidates waited less than 1 year in 2016, compared with 36.0% in 2006 (Table LI 15). Candidates listed for multi-organ transplants including liver increased over time. Liver-kidney transplant candidates accounted for only 1.7% of pediatric liver transplant candidates in 2006 and for 4.3% in 2016. The proportion of liver-pancreas-intestine transplant candidates doubled from 6.8% in 2006 to 14.2% in 2016 (Table LI 15). Among candidates removed from the waiting list in 2016, 70.1% received a deceased donor liver, 8.2% received a living donor liver, 4.7% died, 8.0% were removed from the list because their condition improved, and 2.9% were considered too sick to undergo transplant (Table LI 17). Approximately 72% of candidates newly listed in 2013 underwent deceased donor transplant within 3 years, 6.7% underwent living donor transplant, 4.2% died, 10.8% were removed from the list, and 6.8% were still waiting (Figure LI 79). In 2016, the rate of deceased donor transplant among active pediatric candidates was 134.0 per 100 active waitlist years (Figure LI 80). Rates were highest for candidates aged younger than 1 year, 242.7 per 100 active waitlist years, an increase from 2015. The lowest rates were for candidates aged 11 years or older (103.3 per 100 active waitlist years). Regarding medical urgency status, transplant rates were highest (216.5 per 100 active waitlist years) for candidates with MELD/PELD 35 or higher, compared with 33.2 for those with MELD/PELD below 15 (Figure LI 81). Pretransplant mortality decreased for all age groups, to 5.5 deaths per 100 waitlist years in 2015-2016 (Figure LI 82). The pretransplant mortality rate was highest for candidates aged younger than 1 year, at 12.7 deaths per 100 waitlist years in 2015-2016, but it has steadily declined over the past decade from a peak of 40.9 in 2005-2006.

2.2 Transplant

The number of pediatric liver transplants peaked at 613 in 2008 and was 573 in 2016 (Figure LI 84). The number of pediatric living donor liver transplants decreased from a peak of 79 in 2015 to 62 in 2016, with most from donors closely related to the recipients (Figure LI 84, Figure LI 85). Recipients aged younger than 6 years received 14% of livers from living donors (Figure LI 86). In 2016, 24 programs were performing pediatric-only liver transplants, compared with 87 performing adult-only transplants and 27 performing transplants in both adults and children (Figure LI 87). In 2016, 11.5% of transplants in candidates aged 0-14 years were performed at programs with volumes of 5 or fewer pediatric transplants in that year (Figure LI 88). In 2016, the median cold ischemia time was similar by allocation MELD/PELD at approximately 6 hours (Figure LI 89). Over the past decade of pediatric liver transplant, recipient age, sex, and racial distributions have changed little (Table LI 18). Cholestatic bil-

iliary atresia remained the leading cause of liver failure (32.3%) (Table LI 19). Most (63.8%) pediatric liver transplant recipients were not hospitalized before transplant and fewer were in the intensive care unit, 28.0% in 2004-2006 vs. 18.2% in 2014-2016. Regarding medical urgency status, MELD/PELD exception use increased from 24.3% in 2004-2006 to 40.0% in 2014-2016. Thirty-five percent of recipients underwent transplant as status 1A/1B, and 23.4% had MELD/PELD scores of 35 or higher, compared with only 9.7% a decade earlier. Twenty percent of recipients had a MELD/PELD score of 15-29 at the time of transplant. Types of liver transplant procedures in pediatric recipients changed little over the past decade; 63.5% of patients received a whole liver in 2014-2016, 22.0% received a partial liver (i.e., less than a whole liver was transplanted, possibly from a living donor, and the remainder was not), and 14.4% received a split liver (i.e., two recipients, usually an adult and a child, received one deceased donor liver) (Table LI 20). ABO-incompatible liver transplants occurred in 4.8% of recipients in 2014-2016, up from 2.2% in the earlier era. In 2014-2016, 8.6% of liver transplant recipients had undergone previous transplant, a decrease from 11.0% a decade earlier.

2.3 Immunosuppression and Outcomes

In 2016, 57.1% of pediatric liver transplant recipients received no induction therapy, 27.5% received interleukin-2 receptor antagonists, and 15.8% received a T-cell depleting agent (Figure LI 90). The most commonly used initial immunosuppression agents included tacrolimus (95.3%) (Figure LI 91), steroids (76.1%) (Figure LI 94), and mycophenolate (39.9%) (Figure LI 92). Use of mTOR inhibitors at the time of transplant was minimal (1.1%), but increased to 8.3% at 1 year posttransplant (Figure LI 93). At 1 year posttransplant, 58.9% of recipients were still receiving steroids (Figure LI 94).

Graft survival continued to improve over the past decade among recipients of deceased donor and living donor livers. Graft failure occurred in 8.9% at 6 months and in 10.5% at 1 year among deceased donor liver transplants performed in 2015, in 16.1% at 3 years for transplants performed in 2013, in 18.5% at 5 years for transplants performed in 2011, and in 29.9% at 10 years for transplants performed in 2006 (Figure LI 96). Graft failure occurred in 4.4% of recipients at 6 months and in 5.1% at 1 year posttransplant among living donor transplants performed in 2014-2015, in 8.5% at 3 years for transplants performed in 2012-2013, in 14.0% at 5 years for transplants performed in 2010-2011, and in 18.4% at 10 years for transplants performed in 2004-2005 (Figure LI 97). By age, 5-year graft survival was 77.5% for recipients aged younger than 1 year, 78.8% for ages 1-5 years, 88.0% for ages 6-10 years, and 80.2% for ages 11-17 years (Figure LI 98). Recipients who underwent transplant with a MELD/PELD less than or equal to 20 had 5-year graft survival of 86.7%, compared with 77.9% for recipients who underwent transplant as status 1A/1B or with a MELD/PELD greater than 20 (Figure LI 100). Five-year graft survival was 81.3% for recipients of a first liver transplant, compared with 68.8% for retransplant recipients (Figure LI 101). In 2014-2015, the incidence of acute rejection was 28.1% overall, varying from 30.0% in recipients aged 11-17 years to 24.6% in those aged younger than 1 year (Figure LI 102). Incidence of posttransplant lymphoproliferative disorder was 4.5% at 5 years posttransplant for recipients who were negative for Epstein-Barr virus and 2.8% for those who were positive (Figure LI 103). Among liver transplants 2007-2011, overall 5-year patient survival was 86.2%, varying from 84.8% for recipients aged 1-5 years to 91.7%

for those aged 6-10 years (Figure LI 104). By primary diagnosis, metabolic disease and cholestatic biliary atresia were associated with the best patient survival (Figure LI 105). Of deceased donor transplant recipients in 2009-2011, 12.1% died within 5 years of transplant (Figure LI 107). The leading cause of death was infection (2.0%), followed by cardio/cerebrovascular complications (1.5%).

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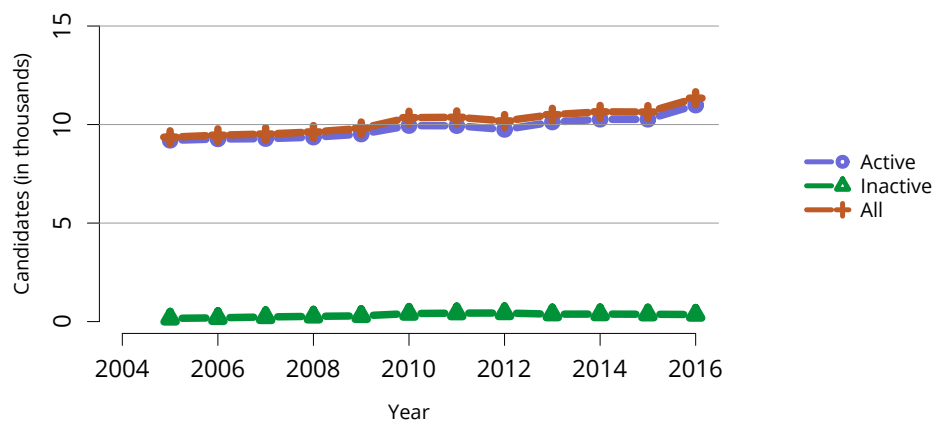


Figure LI 1. New adult candidates added to the liver transplant waiting list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates concurrently listed at multiple centers are counted once. Active and inactive patients are included.

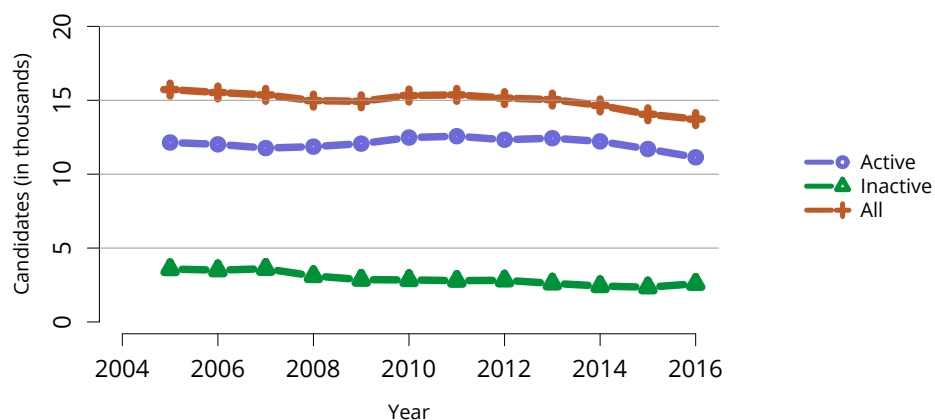


Figure LI 2. Adults listed for liver transplant on December 31 each year. Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

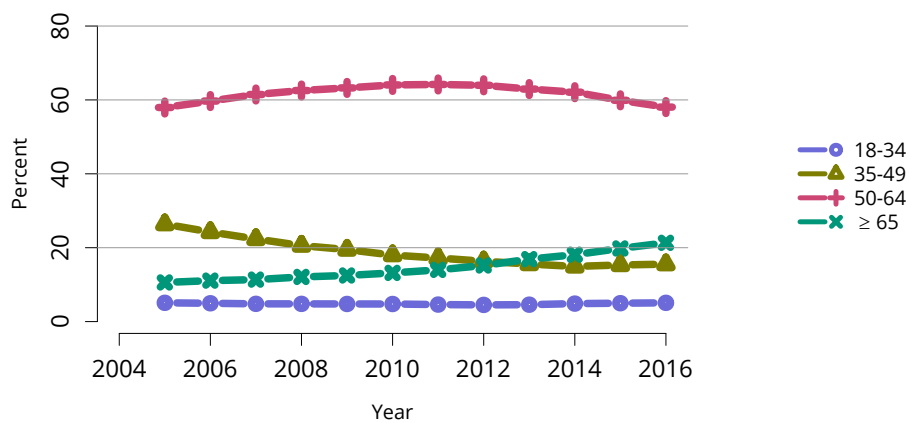


Figure LI 3. Distribution of adults waiting for liver transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.

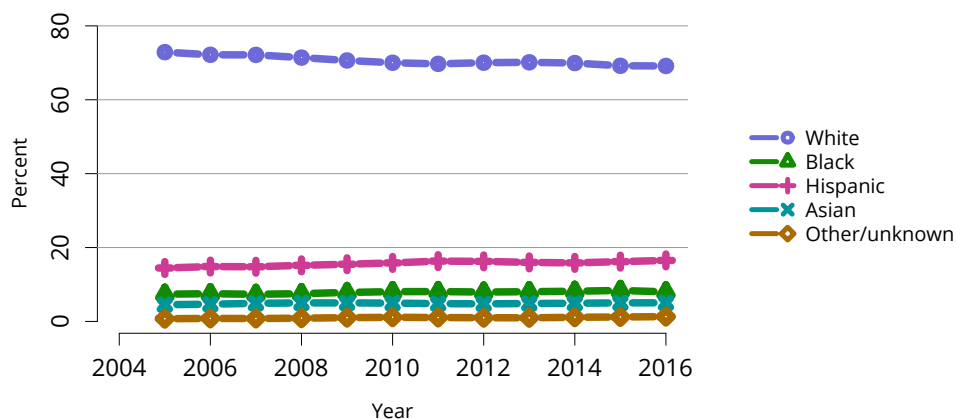


Figure LI 4. Distribution of adults waiting for liver transplant by race. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included.

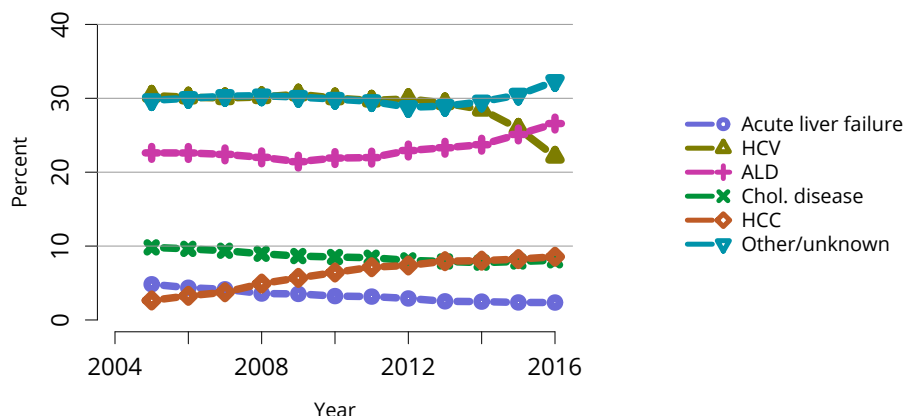


Figure LI 5. Distribution of adults waiting for liver transplant by diagnosis. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease.

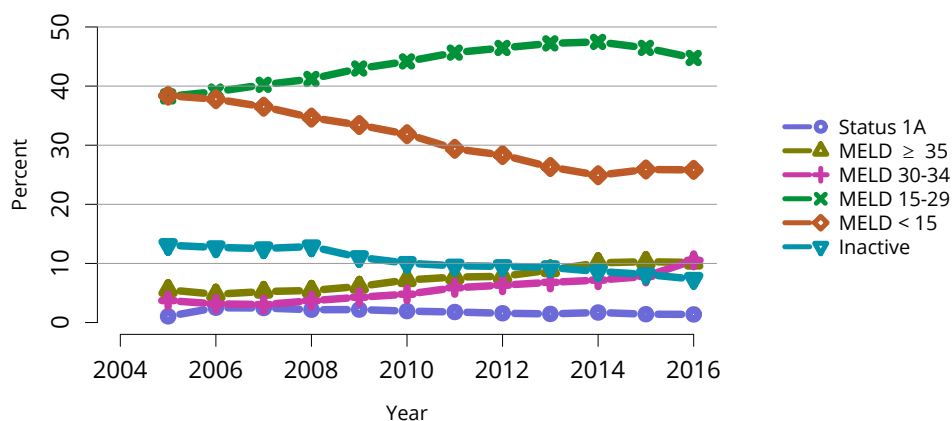


Figure LI 6. Distribution of adults waiting for liver transplant by medical urgency. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Medical urgency status is the most severe during the year. Active and inactive patients are included.

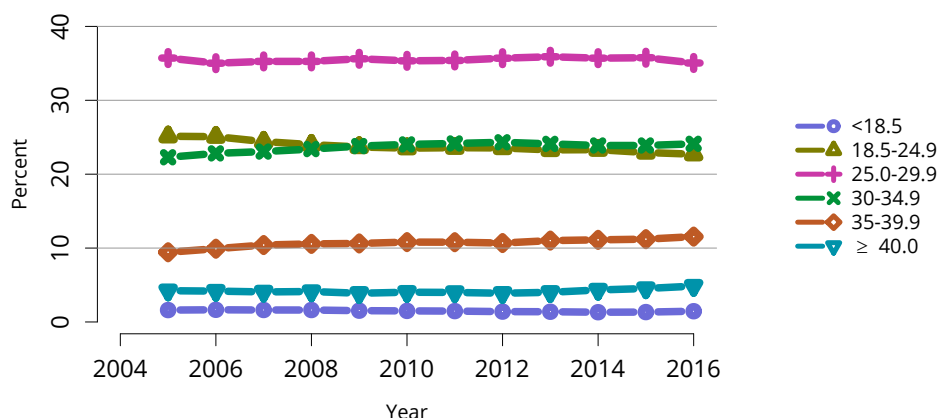


Figure LI 7. Distribution of adults waiting for liver transplant by BMI. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive patients are included.

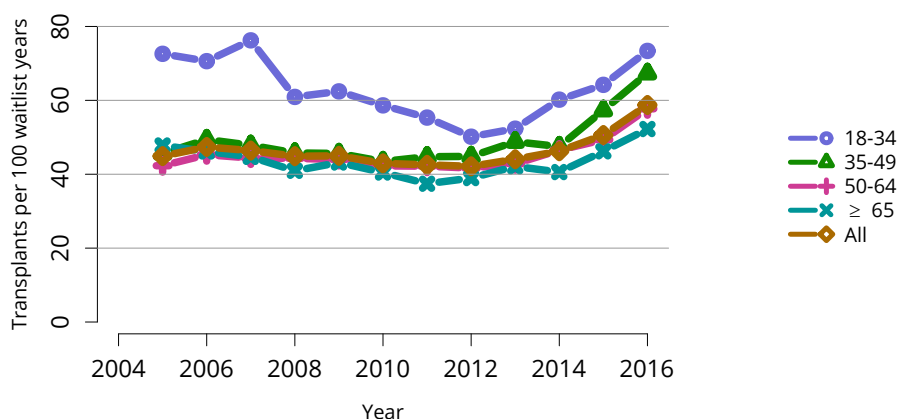


Figure LI 8. Deceased donor liver transplant rates among active adult waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active wait time in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure are not shown.

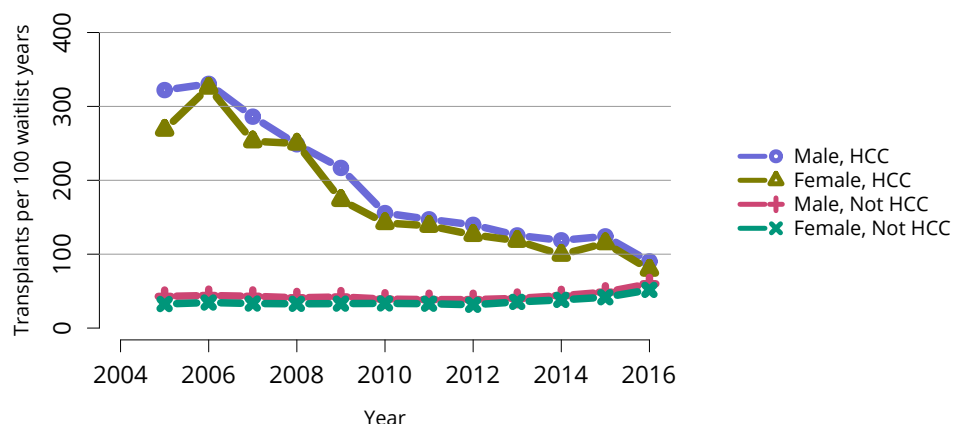


Figure LI 9. Deceased donor liver transplant rates among active adult waitlist candidates by sex and HCC exception status. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active wait time in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. Hepatocellular carcinoma (HCC) candidates have active Stage 2 exception points (per OPTN policy 9.3.G) in the given year.

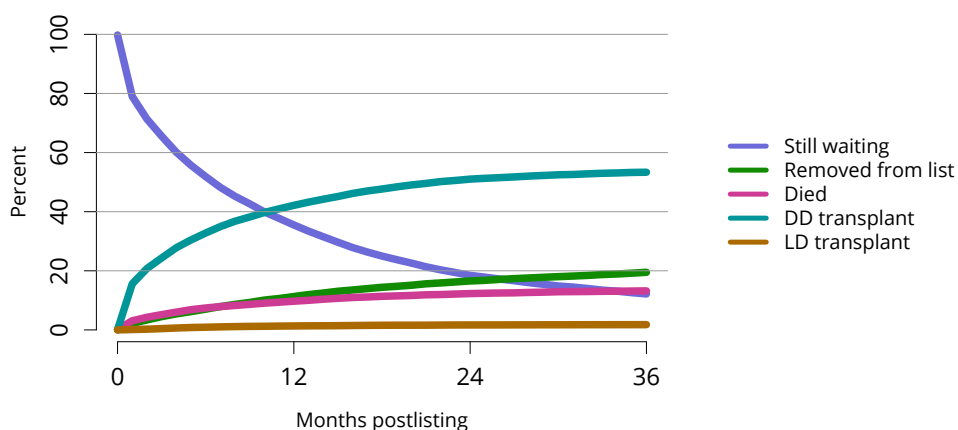


Figure LI 10. Three-year outcomes for adults waiting for liver transplant, new listings in 2013. Adults waiting for any liver transplant and first listed in 2013. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Removed from list includes all reasons except transplant and death. DD, deceased donor; LD, living donor.

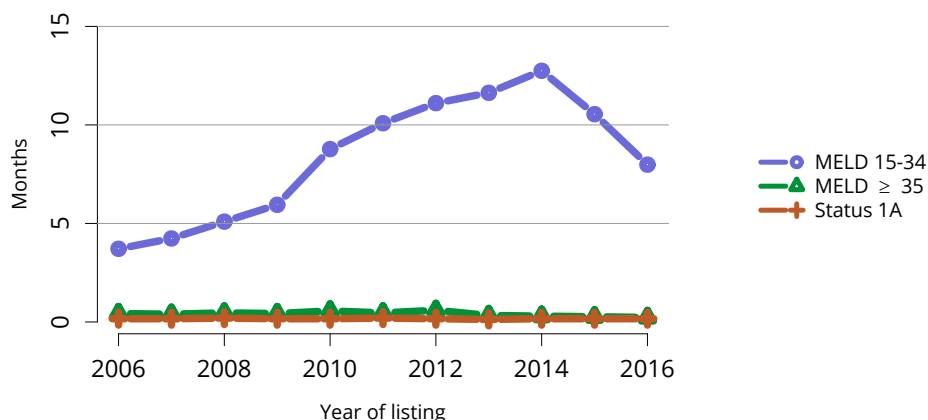


Figure LI 11. Median months to liver transplant for waitlisted adults. Observations censored on December 31, 2016; Kaplan-Meier competing risk methods used to estimate time to transplant. Analysis performed per candidate, not per listing. If an estimate is not plotted, 50% of the cohort listed in that year had not undergone transplant by the censoring date. Only the first transplant is counted.

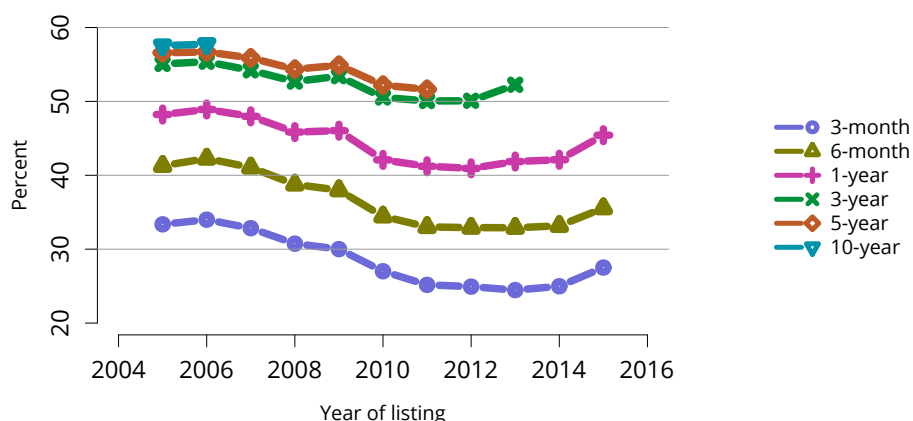


Figure LI 12. Percentage of adults who underwent deceased donor liver transplant within a given time period of listing. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal.

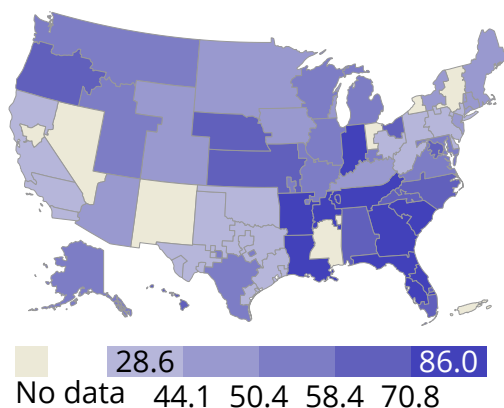


Figure LI 13. Percentage of adults who underwent deceased donor liver transplant within 5 years of listing in 2011 by DSA. Candidates listed concurrently in a single DSA are counted once in that DSA, from the time of earliest listing to the time of latest removal; candidates listed in multiple DSAs are counted separately per DSA.

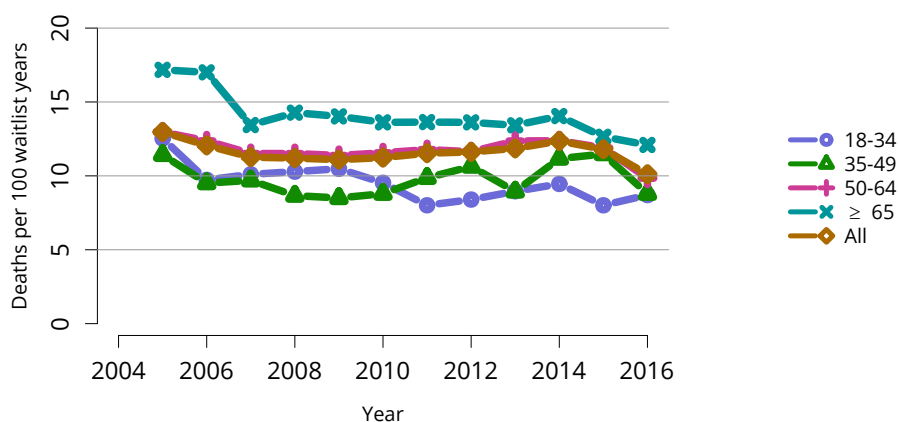


Figure LI 14. Pretransplant mortality rates among adults waitlisted for liver transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. Age is determined at the later of listing date or January 1 of the given year.

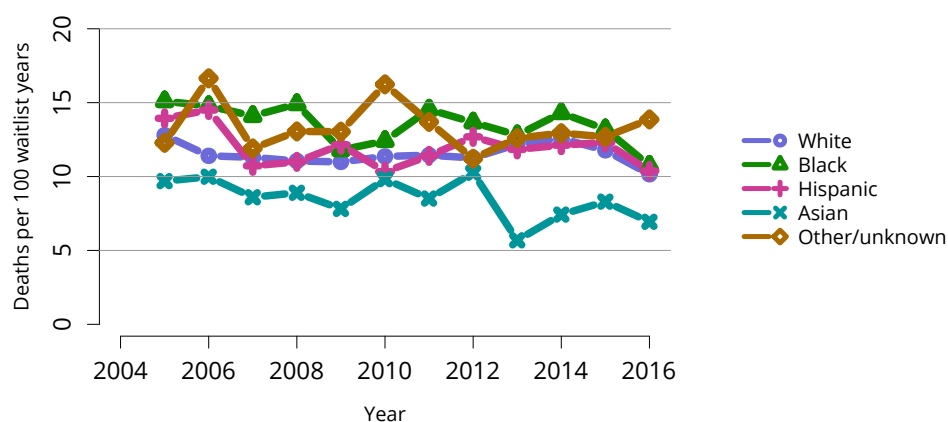


Figure LI 15. Pretransplant mortality rates among adults waitlisted for liver transplant by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

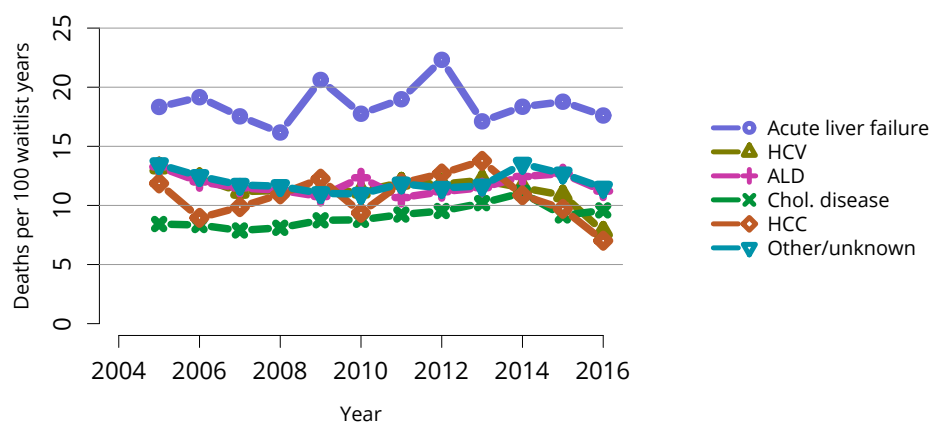


Figure LI 16. Pretransplant mortality rates among adults waitlisted for liver transplant by diagnosis. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease.

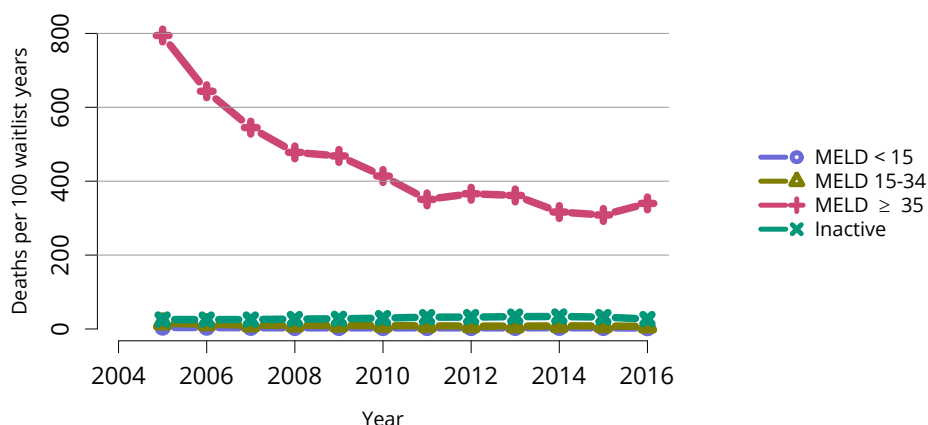


Figure LI 17. Pretransplant mortality rates among adults waitlisted for liver transplant by medical urgency. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

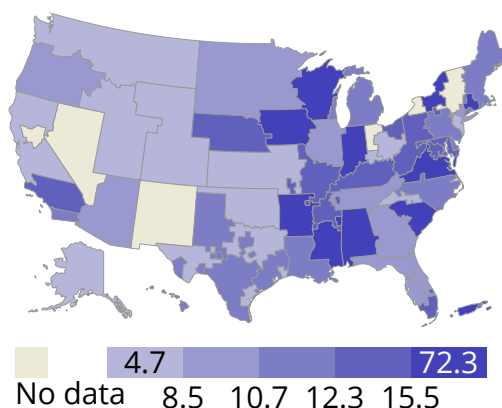


Figure LI 18. Pretransplant mortality rates among adults waitlisted for liver transplant in 2015-2016, by DSA. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Patients censored at waitlist removal. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

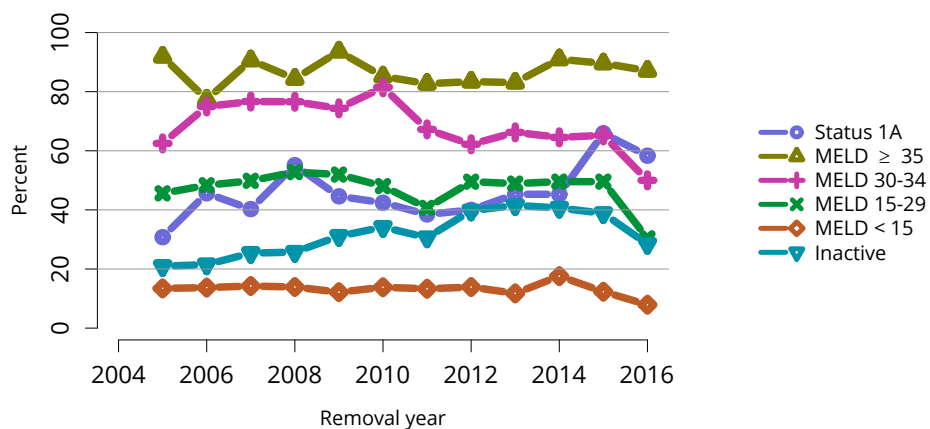


Figure LI 19. Deaths within six months after removal among adult liver waitlist candidates. Denominator includes only candidates removed from the waiting list for reasons other than transplant or death while on the list.

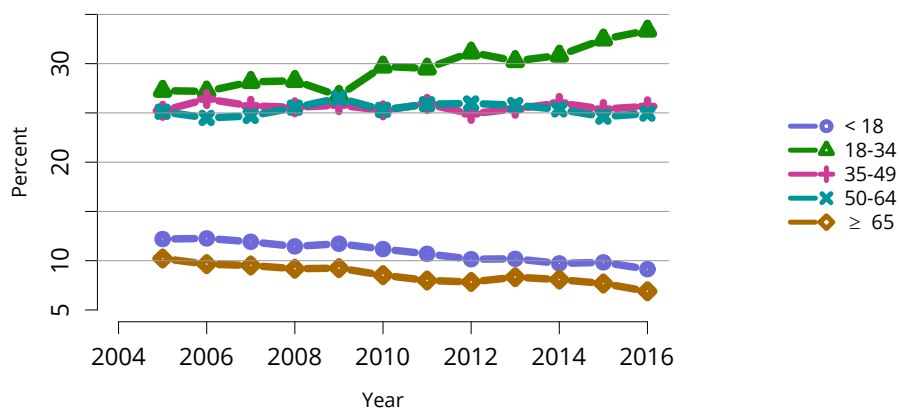


Figure LI 20. Deceased liver donors by age. Deceased donors whose livers were recovered for transplant.

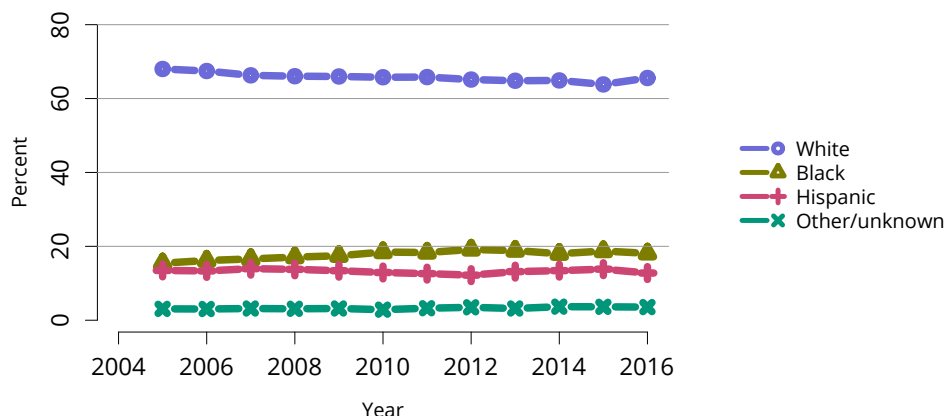


Figure LI 21. Deceased liver donors by race. Deceased donors whose livers were recovered for transplant.

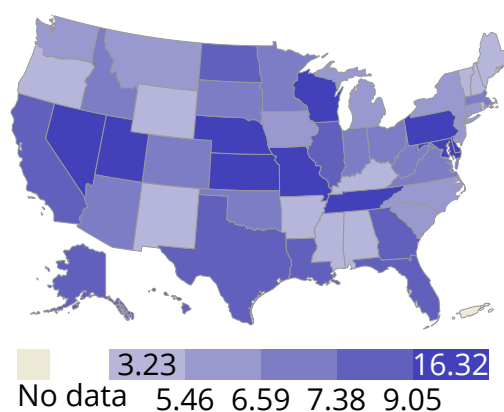


Figure LI 22. Deceased donor liver donation rates (per 1000 deaths) by state, 2013-2015. Numerator: Deceased donors aged < 70 years, by state of death, whose liver was recovered for transplant from 2013 through 2015. Denominator: US deaths aged < 70 years, by state of death, from 2013 through 2015. State death data by age obtained through agreement with NAPHSIS (<https://www.naphsis.org/research-requests>).

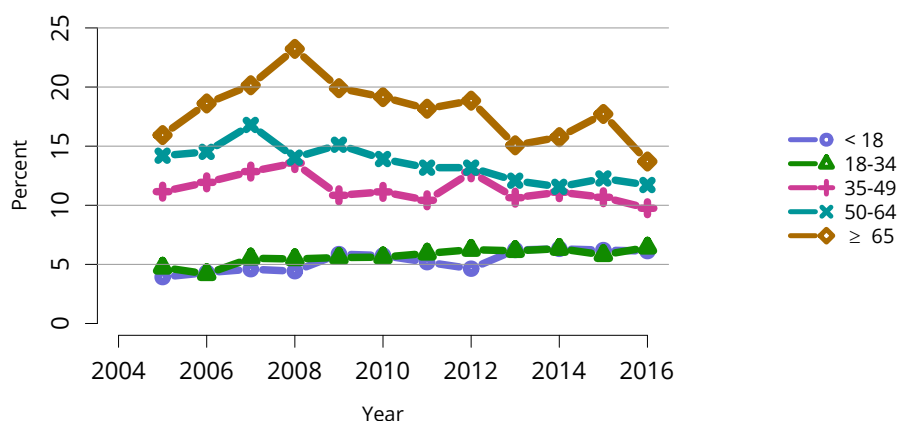


Figure LI 23. Rates of livers recovered for transplant and not transplanted by age. Percentages of livers not transplanted out of all livers recovered for transplant.

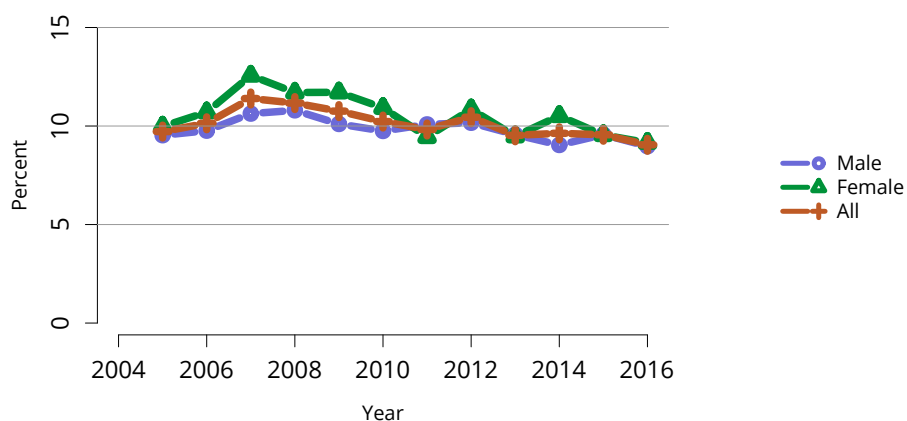


Figure LI 24. Rates of livers recovered for transplant and not transplanted by sex. Percentages of livers not transplanted out of all livers recovered for transplant.

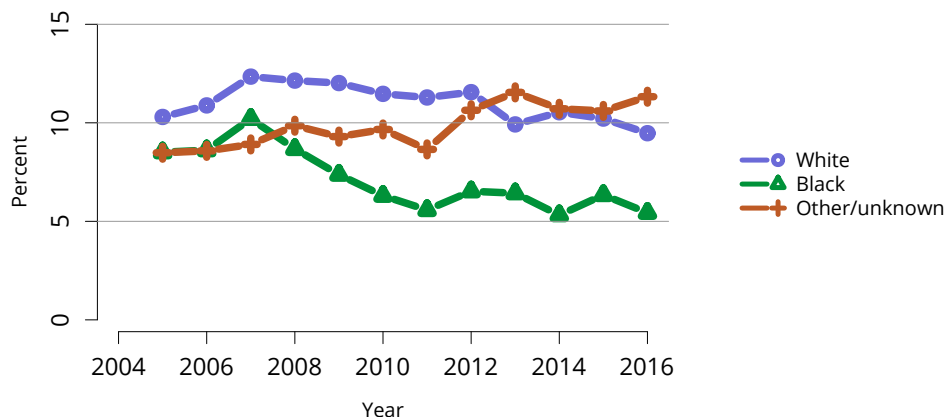


Figure LI 25. Rates of livers recovered for transplant and not transplanted by race. Percentages of livers not transplanted out of all livers recovered for transplant.

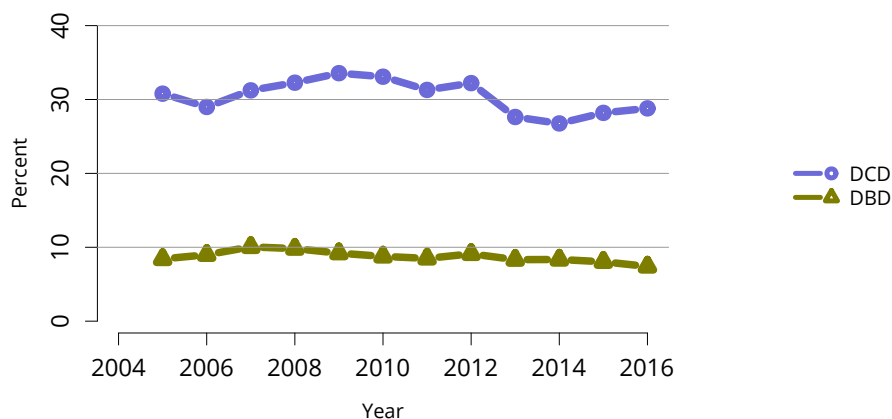


Figure LI 26. Rates of livers recovered for transplant and not transplanted by DCD status. Percentages of livers not transplanted out of all livers recovered for transplant. DBD, donation after brain death; DCD, donation after circulatory death.

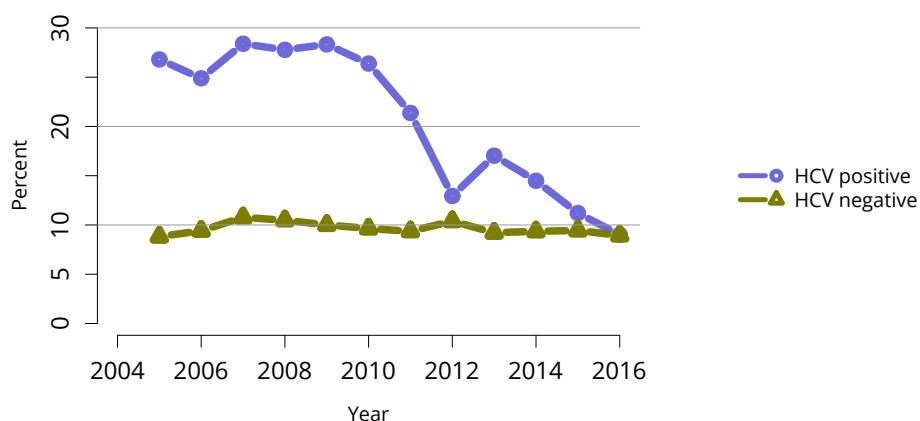


Figure LI 27. Rates of livers recovered for transplant and not transplanted by HCV status. Percentages of livers not transplanted out of all livers recovered for transplant. HCV, hepatitis C virus.

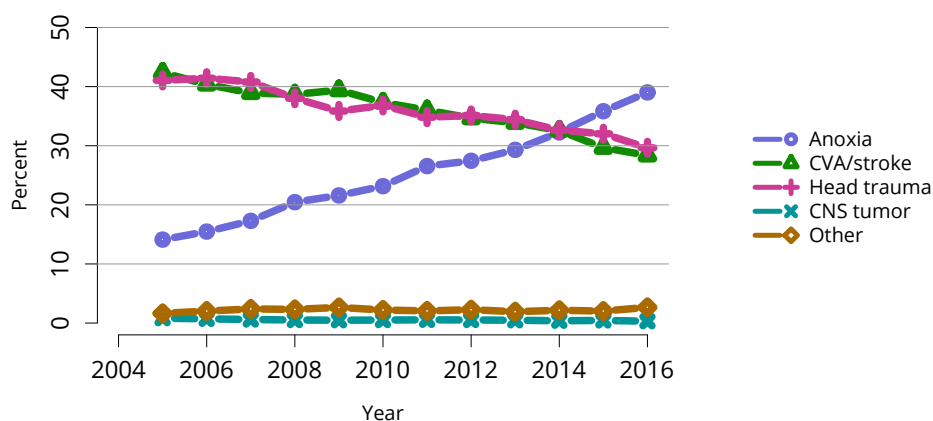


Figure LI 28. Cause of death among deceased liver donors. Deceased donors whose livers were transplanted. CNS, central nervous system; CVA, cerebrovascular accident.

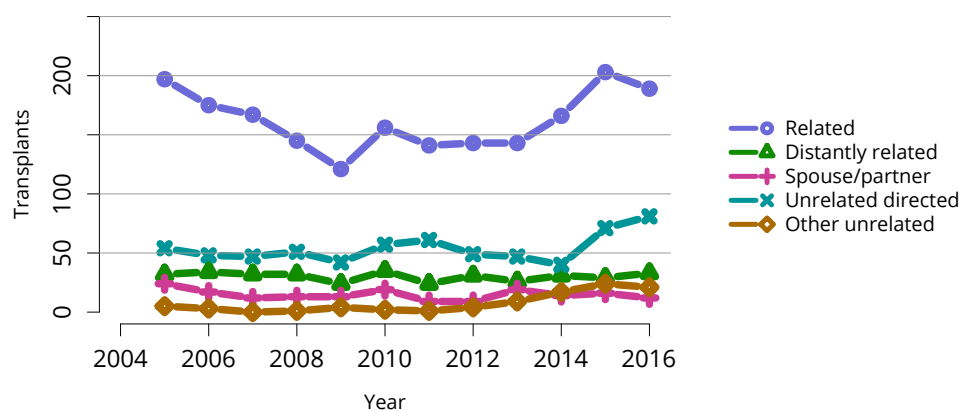


Figure LI 29. Liver transplants from living donors by donor relation. Numbers of living donor donations, excluding domino livers, as reported on the OPTN Living Donor Registration Form.

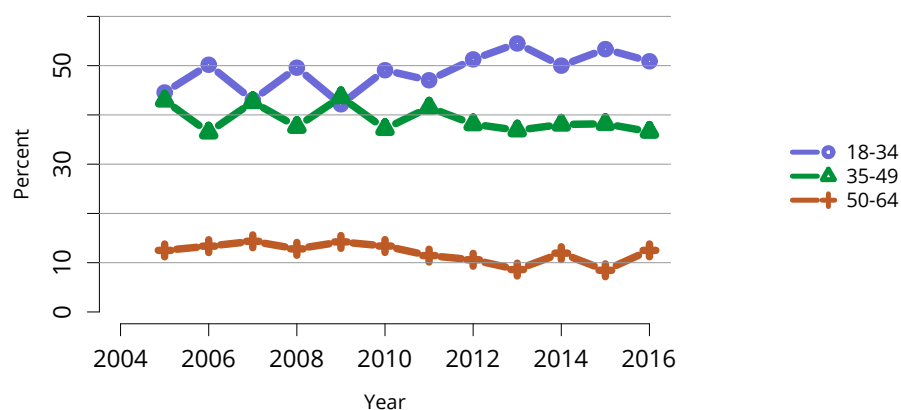


Figure LI 30. Living liver donors by age. As reported on the OPTN Living Donor Registration Form. Domino liver donors excluded.

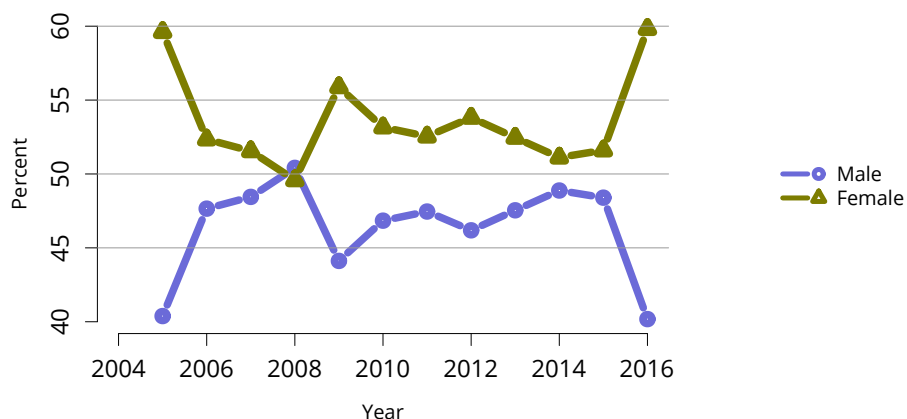


Figure LI 31. Living liver donors by sex. As reported on the OPTN Living Donor Registration Form. Domino liver donors excluded.

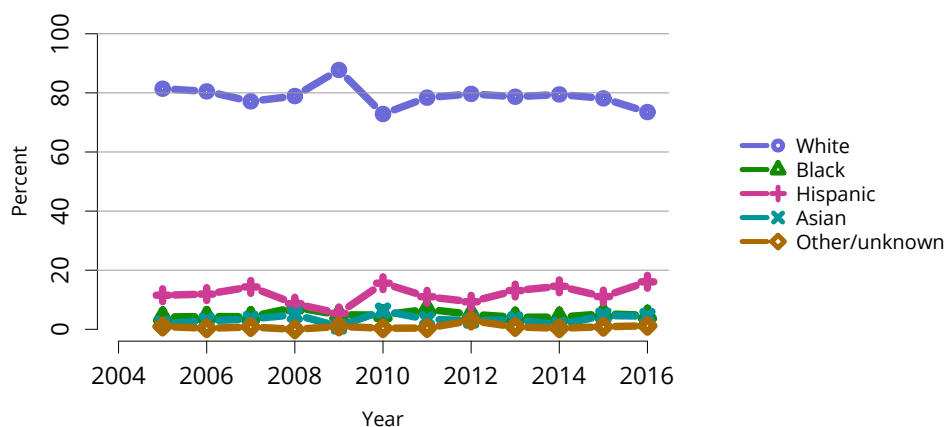


Figure LI 32. Living liver donors by race. As reported on the OPTN Living Donor Registration Form. Domino liver donors excluded.

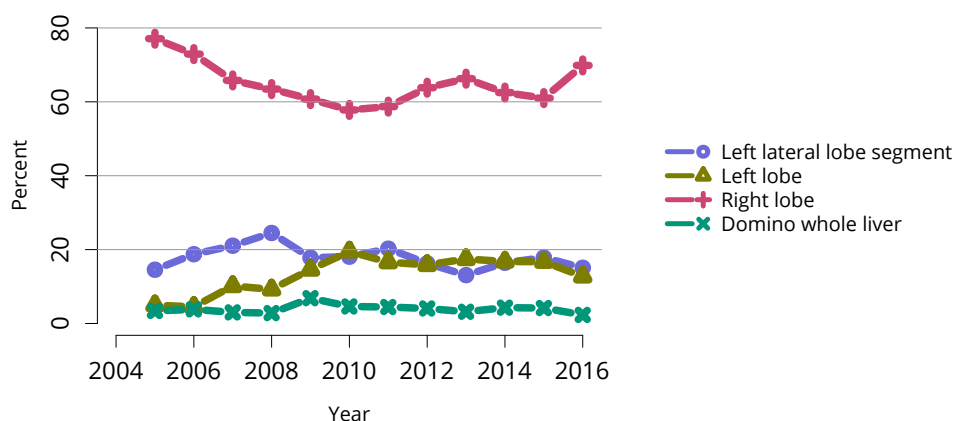


Figure LI 33. Living donor liver transplant graft type. As reported on the OPTN Living Donor Registration Form.

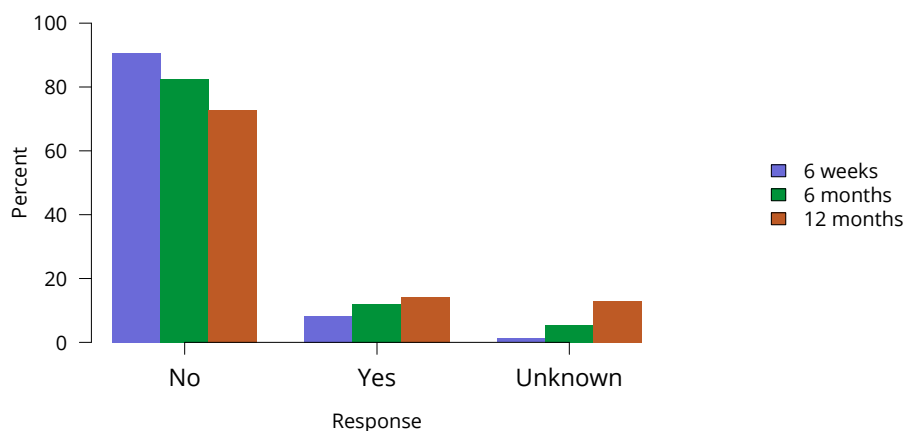


Figure LI 34. Rehospitalization in the first 6 weeks, 6 months, and 1 year among living liver donors, 2011-2015. Cumulative hospital readmission. The 6-week time point is recorded at the earliest of discharge or 6 weeks after donation. Domino liver donors excluded.

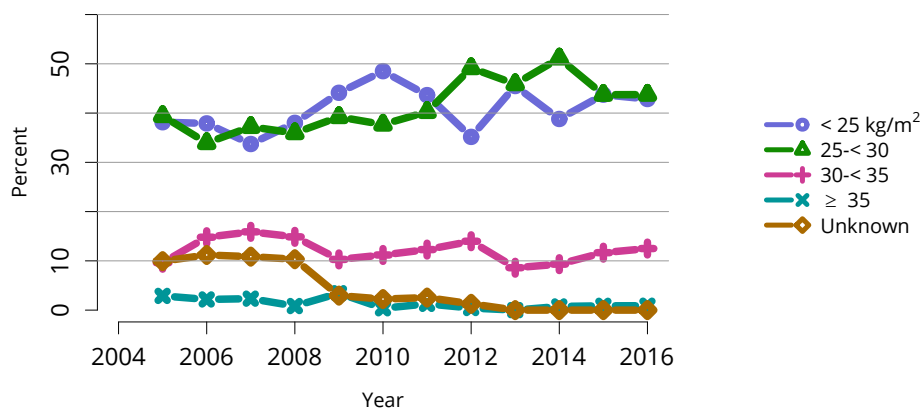


Figure LI 35. BMI among living liver donors. Donor height and weight reported on the OPTN Living Donor Registration Form. Domino liver donors excluded.

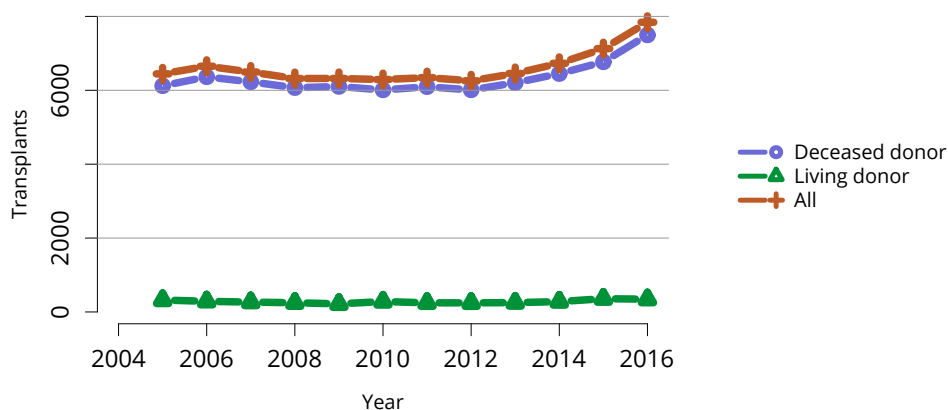


Figure LI 36. Total liver transplants. All liver transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

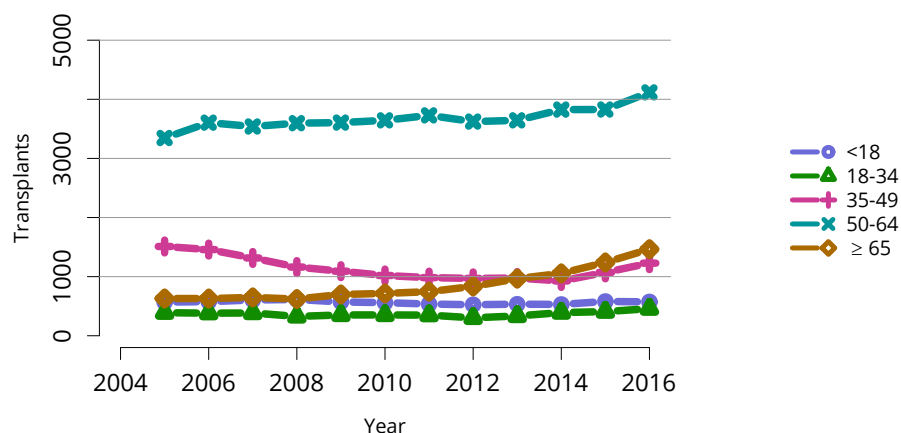


Figure LI 37. Total liver transplants by age. All liver transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

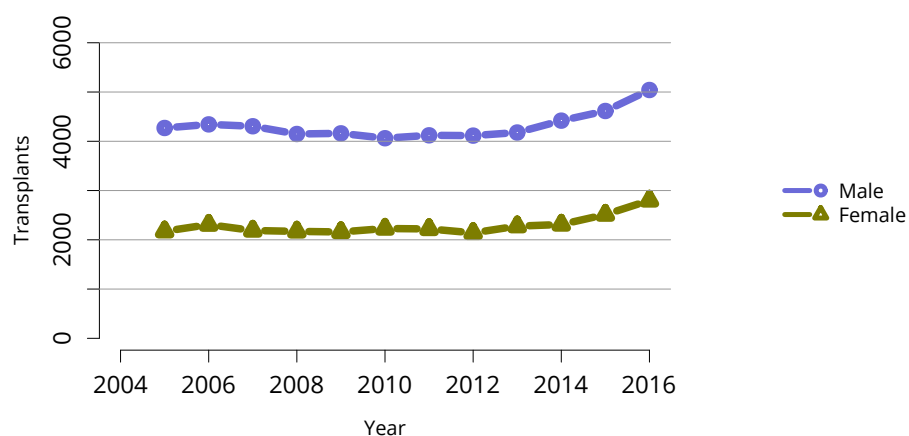


Figure LI 38. Total liver transplants by sex. All liver transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

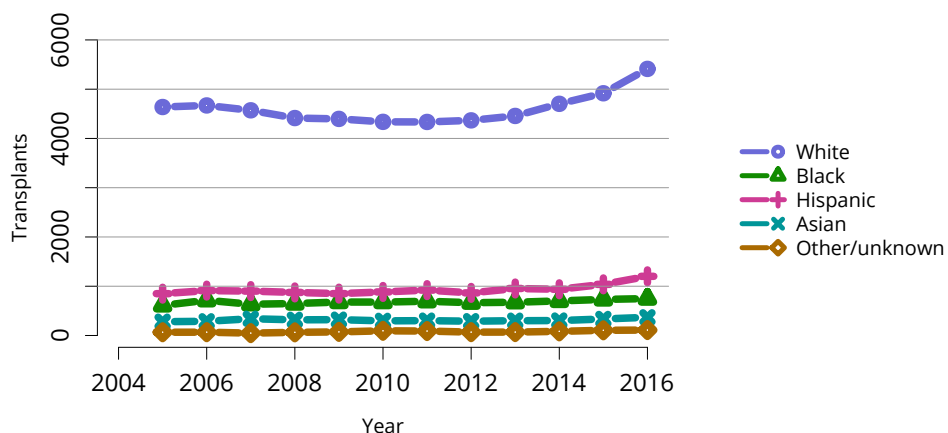


Figure LI 39. Total liver transplants by race. All liver transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

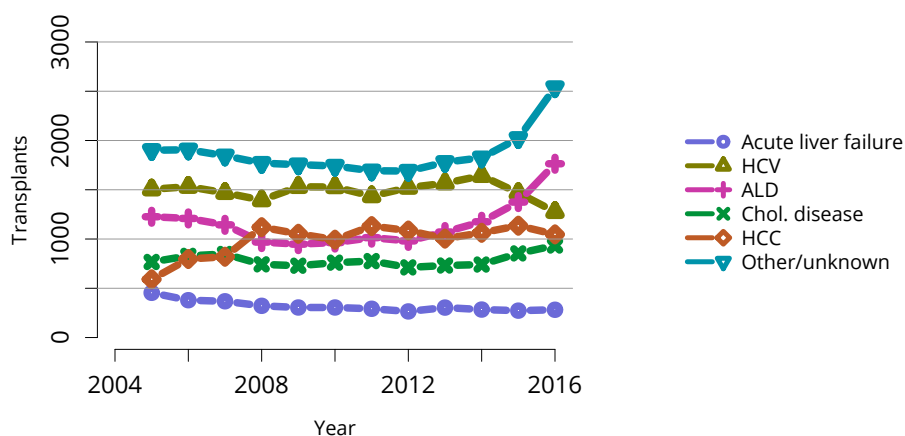


Figure LI 40. Total liver transplants by diagnosis. All liver transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease; HCC, hepatocellular carcinoma.

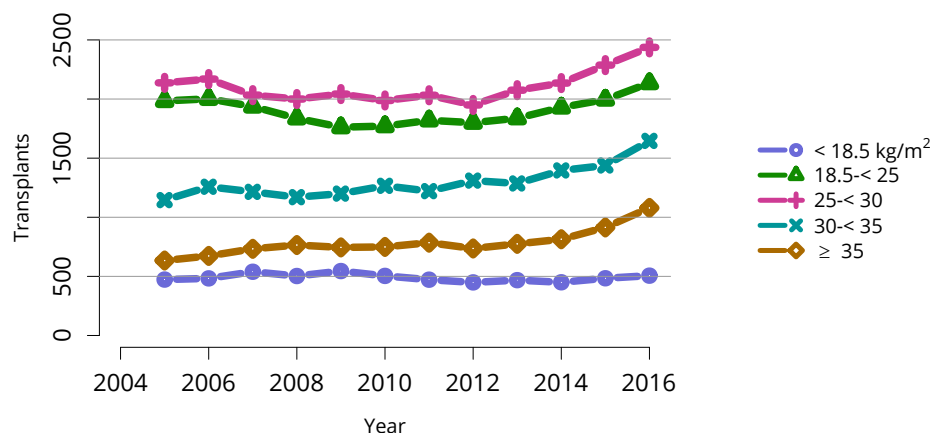


Figure LI 41. Total liver transplants by body mass index (BMI). All liver transplant recipients, including adult and pediatric, retransplant, and multi-organ recipients.

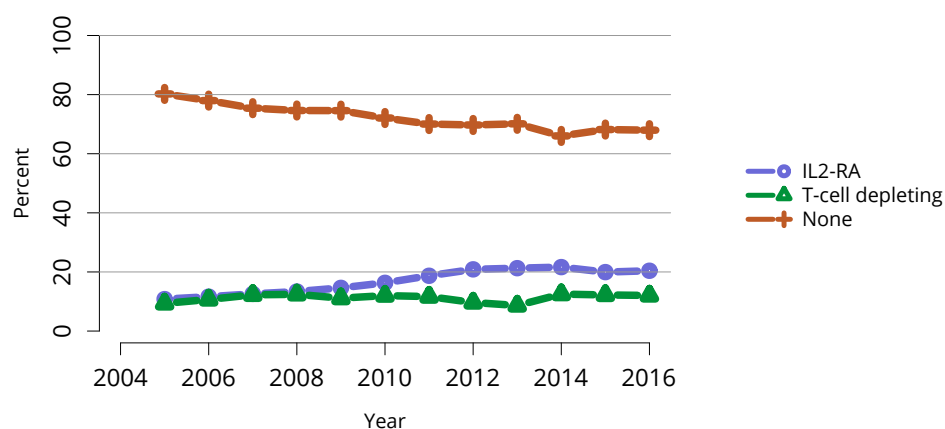


Figure LI 42. Induction agent use in adult liver transplant recipients. Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.

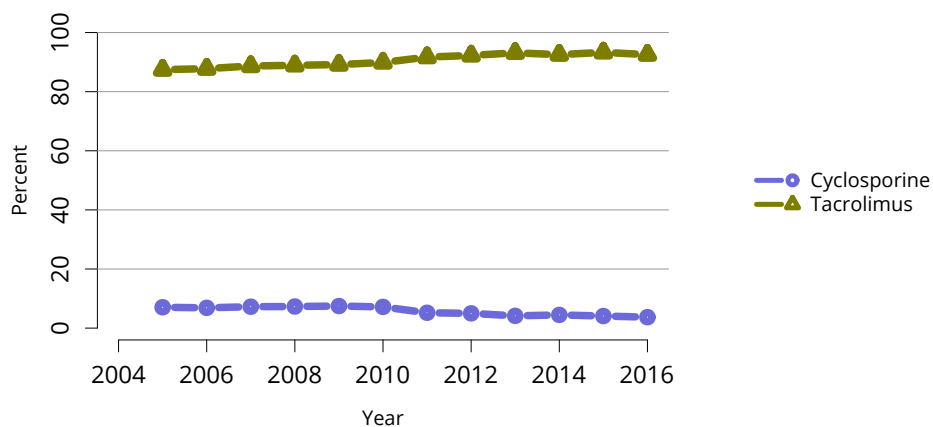


Figure LI 43. Calcineurin inhibitor use in adult liver transplant recipients.
Immunosuppression at transplant reported to the OPTN.

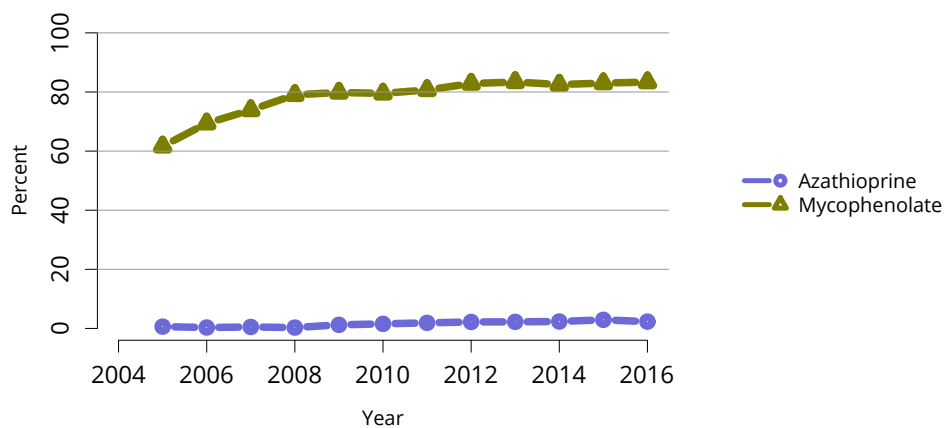


Figure LI 44. Anti-metabolite use in adult liver transplant recipients.
Immunosuppression at transplant reported to the OPTN. Mycophenolate includes mycophenolate mofetil and mycophenolate sodium.

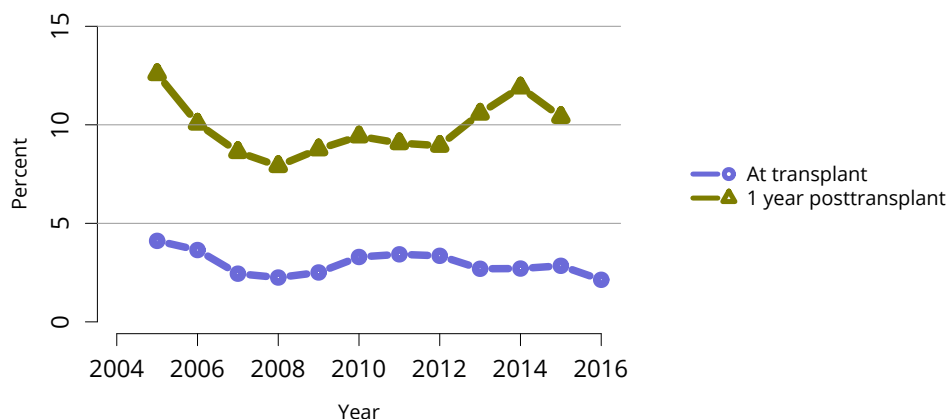


Figure LI 45. mTOR inhibitor use in adult liver transplant recipients. Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant. mTOR, mammalian target of rapamycin.

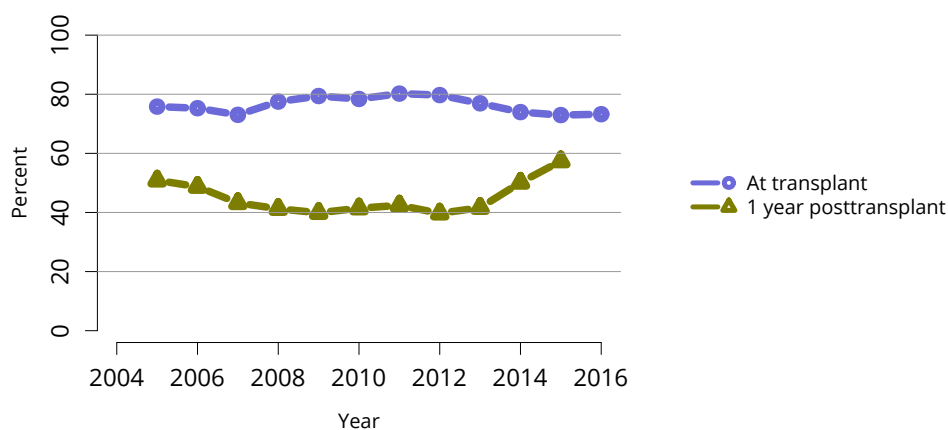


Figure LI 46. Steroid use in adult liver transplant recipients. Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant.

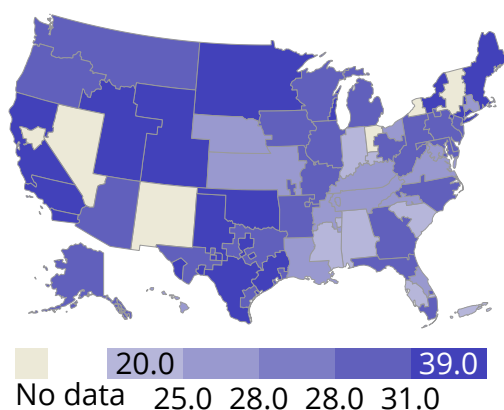


Figure LI 47. Median MELD scores for adult deceased donor liver transplant recipients by DSA, 2016. Deceased donor liver transplants. DSA of transplant center location. Status 1A and inactive status excluded; allocation MELD score used.

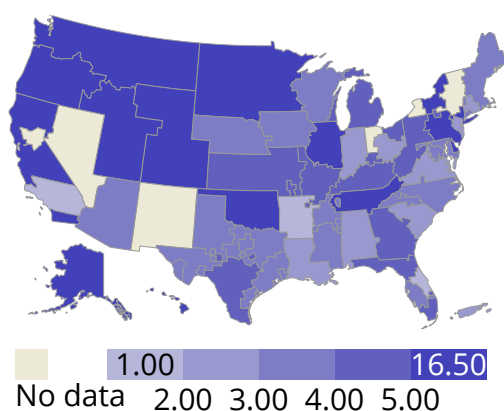


Figure LI 48. Differences in lab MELD and allocation MELD scores among liver transplant recipients by DSA, 2016. Deceased donor liver transplants. DSA of transplant center location. Status 1A and inactive status excluded.

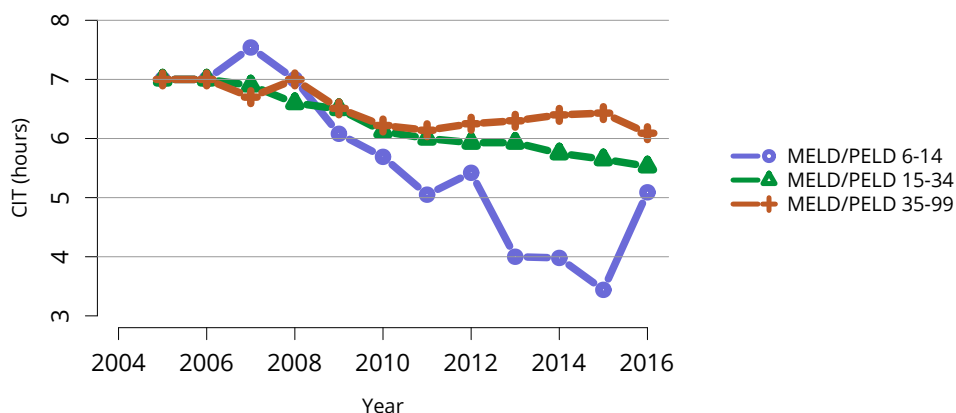


Figure LI 49. Donor liver cold ischemia among adult liver recipients by allocation MELD. Deceased donor liver transplants. Status 1A and inactive status excluded; allocation MELD score used.

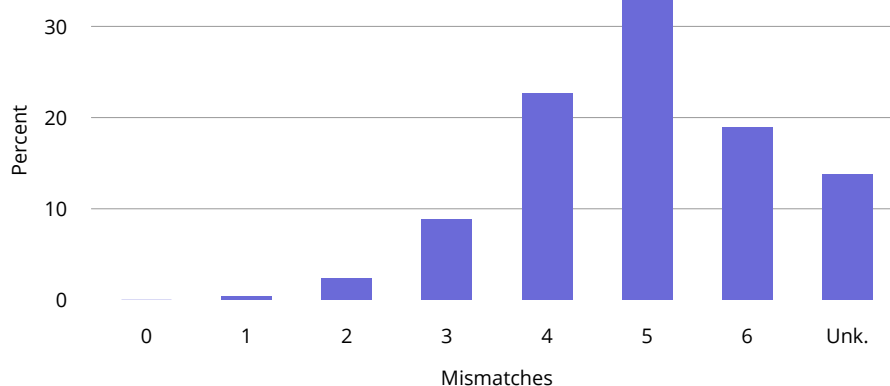


Figure LI 50. Total HLA A, B, and DR mismatches among adult deceased donor liver-kidney transplant recipients, 2012-2016. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2016. Limited to deceased donor liver-kidney transplants only.

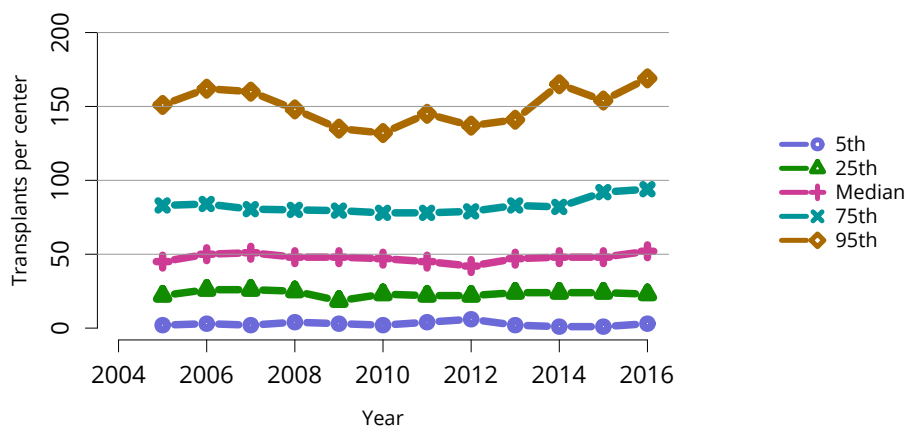


Figure LI 51. Annual adult liver transplant center volumes, by percentile. Annual volume data are limited to recipients aged 18 or older.

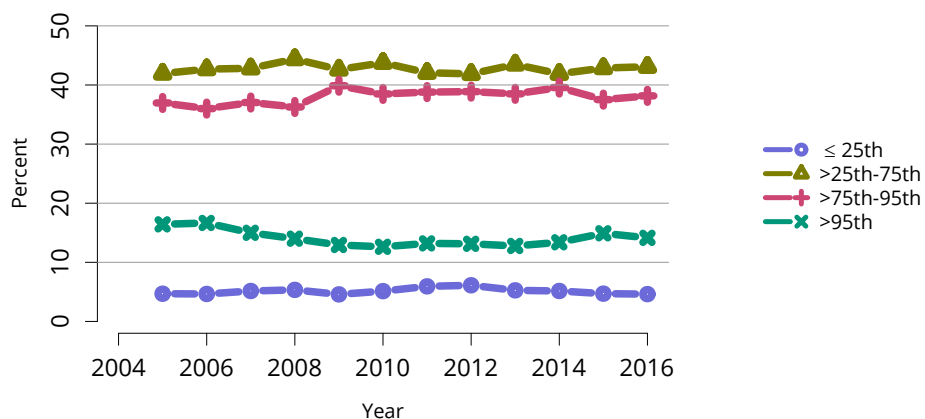


Figure LI 52. Distribution of adult liver transplants by percentile of center volume. Percentiles are based on annual volume data among recipients aged 18 or older.

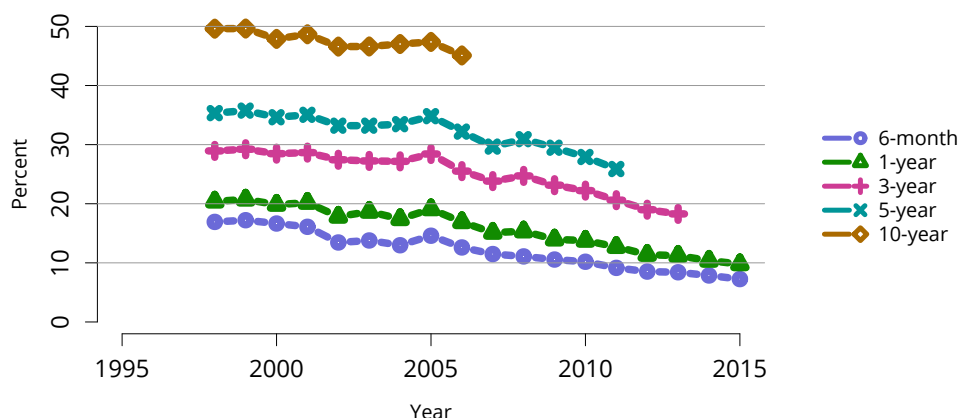


Figure LI 53. Graft failure among adult deceased donor liver transplant recipients. All adult recipients of deceased donor livers, including multi-organ transplants. Patients are followed until the earliest of retransplant, death, or December 31, 2016. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.

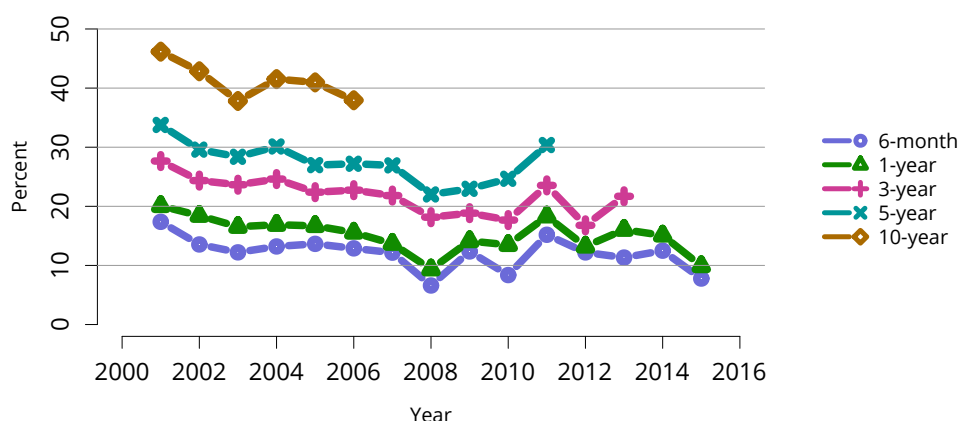


Figure LI 54. Graft failure among adult living donor liver transplant recipients. All adult recipients of living donor livers, including multi-organ transplants. Patients are followed until the earliest of retransplant, death, or December 31, 2016. Estimates computed with Cox proportional hazards models adjusted for age, sex, and race.

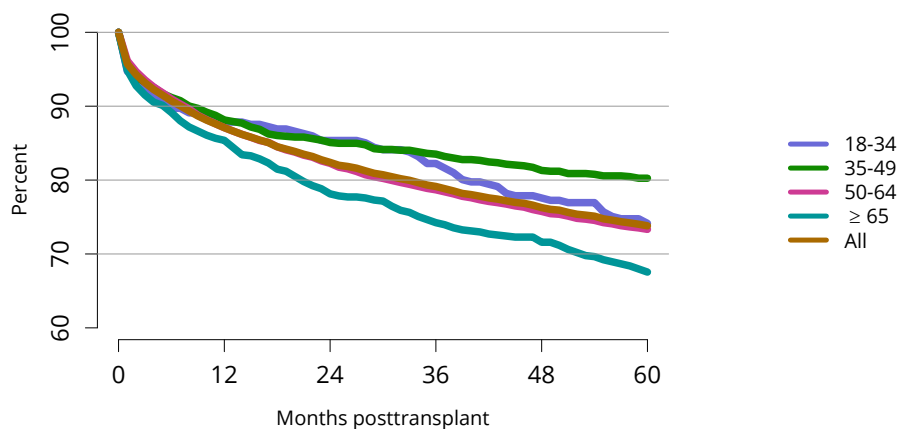


Figure LI 55. Graft survival among adult deceased donor liver transplant recipients, 2011, by age. Graft survival estimated using unadjusted Kaplan-Meier methods.

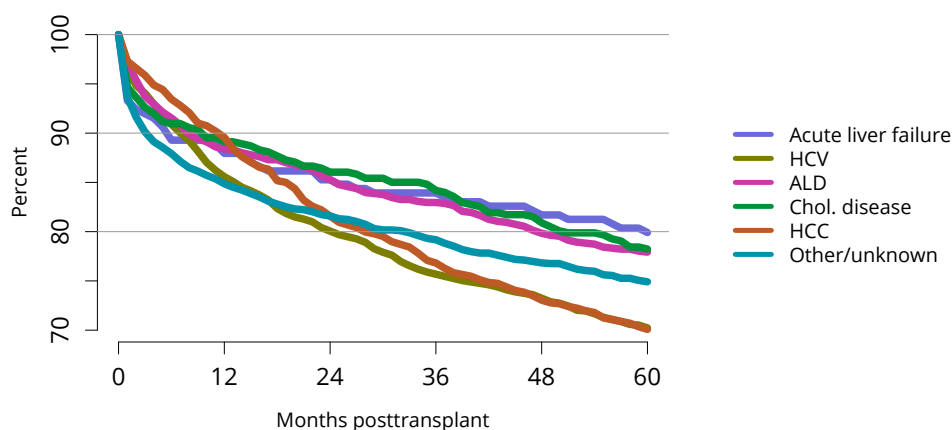


Figure LI 56. Graft survival among adult deceased donor liver transplant recipients, 2011, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease; HCC, hepatocellular carcinoma.

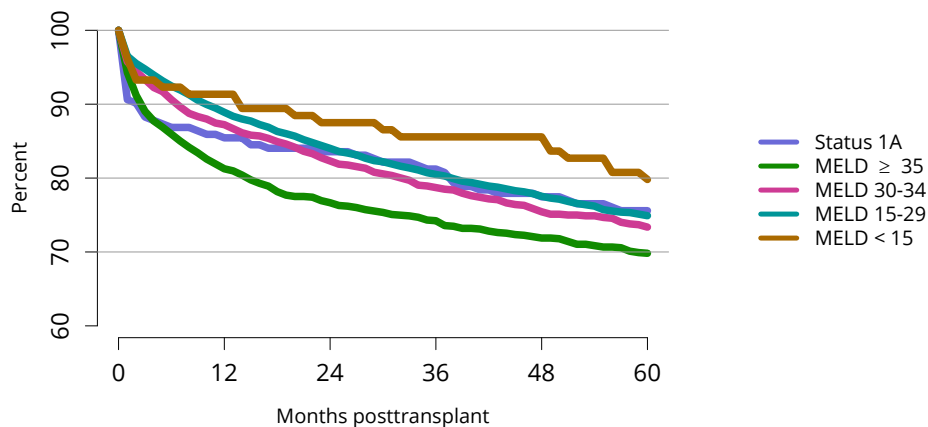


Figure LI 57. Graft survival among adult deceased donor liver transplant recipients, 2011, by medical urgency. Graft survival estimated using unadjusted Kaplan-Meier methods.

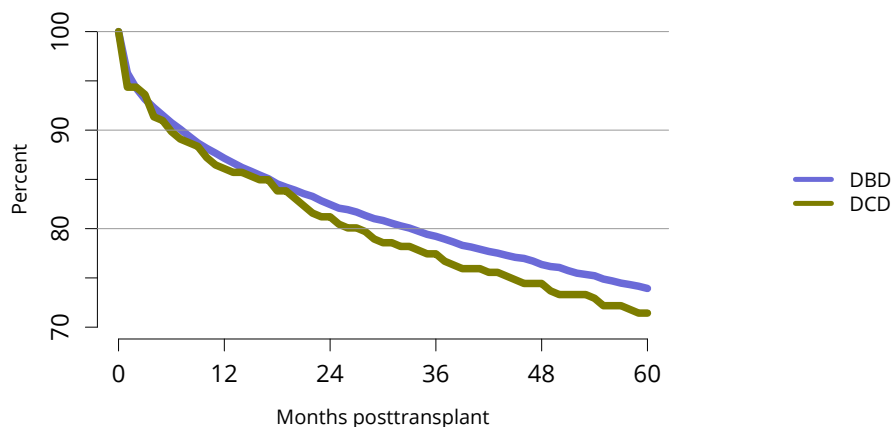


Figure LI 58. Graft survival among adult deceased donor liver transplant recipients, 2011, by DCD status. Graft survival estimated using unadjusted Kaplan-Meier methods. DBD, donation after brain death; DCD, donation after circulatory death.

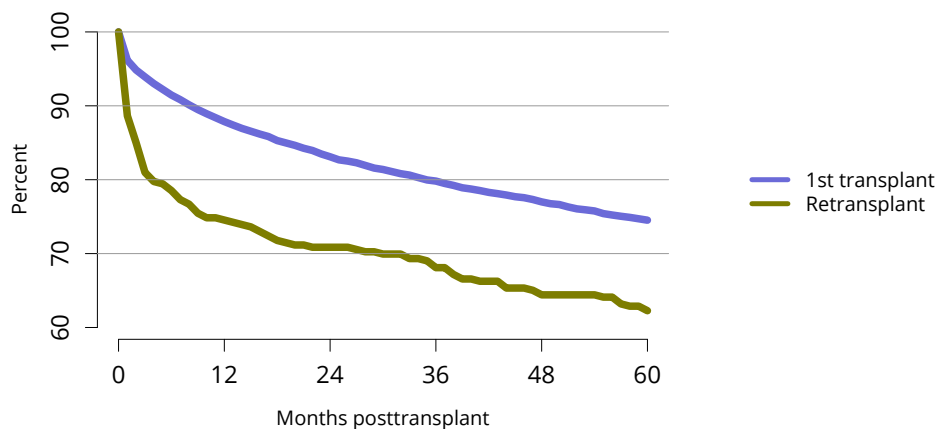


Figure LI 59. Graft survival among adult deceased donor liver transplant recipients, 2011, by retransplant status. Graft survival estimated using unadjusted Kaplan-Meier methods.

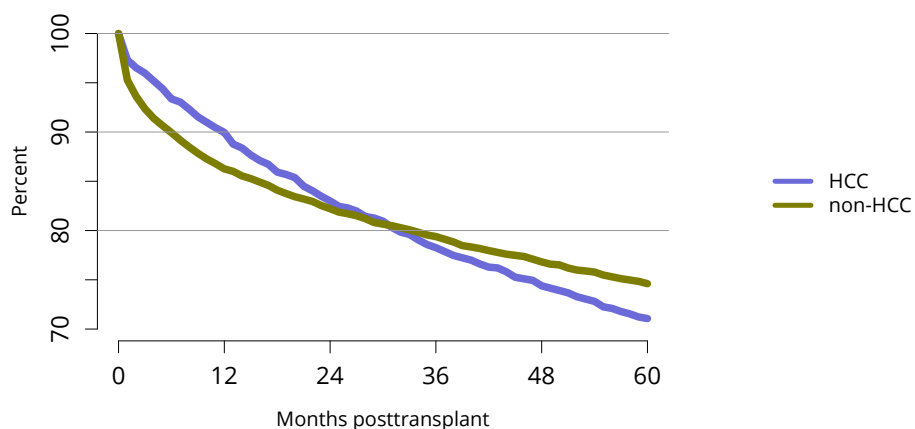


Figure LI 60. Graft survival among adult deceased donor liver transplant recipients, 2011, by HCC status. Graft survival estimated using unadjusted Kaplan-Meier methods. Hepatocellular carcinoma (HCC) is stage T2.

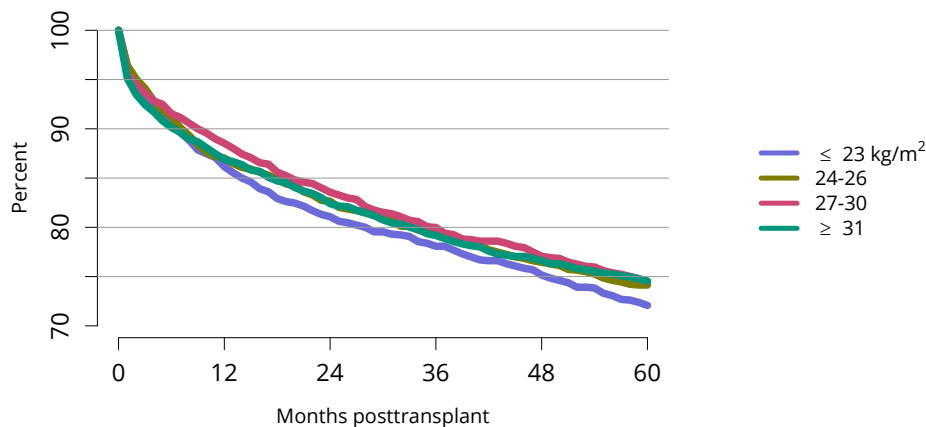


Figure LI 61. Graft survival among adult deceased donor liver transplant recipients, 2011, by BMI. Graft survival estimated using unadjusted Kaplan-Meier methods.

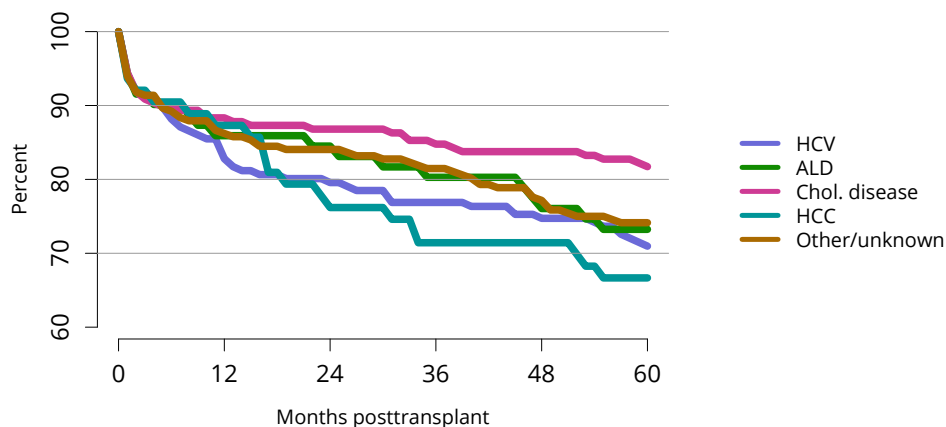


Figure LI 62. Graft survival among adult living donor liver transplant recipients, 2008-2011, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease;.

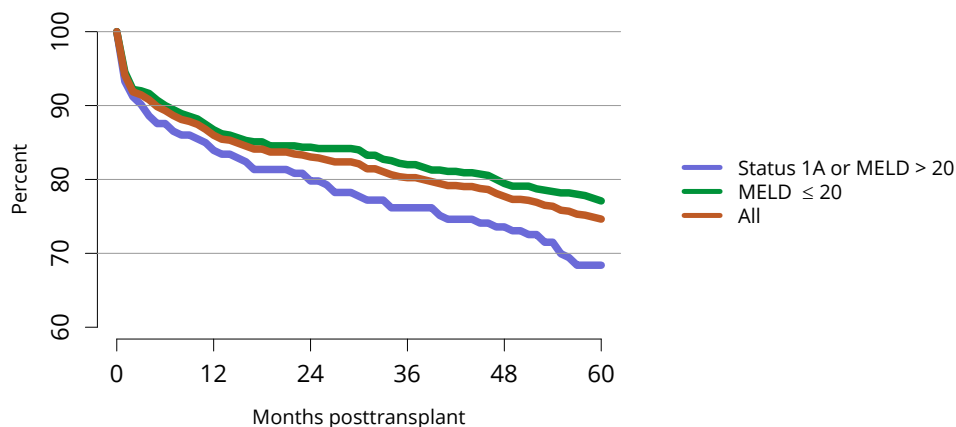


Figure LI 63. Graft survival among adult living donor liver transplant recipients, 2008-2011, by medical urgency. Graft survival estimated using unadjusted Kaplan-Meier methods.

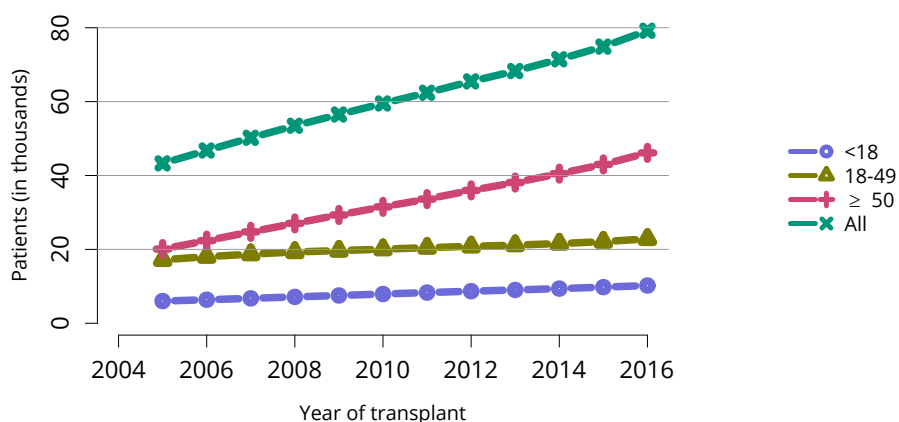


Figure LI 64. Recipients alive with a functioning liver graft on June 30 of the year, by age at transplant. Recipients are assumed to be alive with function unless a death or graft failure is recorded. A recipient may experience a graft failure and be removed from the cohort, undergo retransplant, and re-enter the cohort.

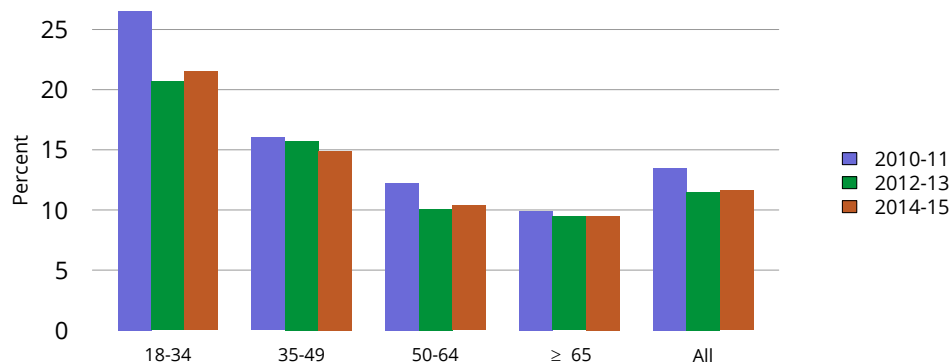


Figure LI 65. Incidence of acute rejection by 1 year posttransplant among adult liver transplant recipients by age. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

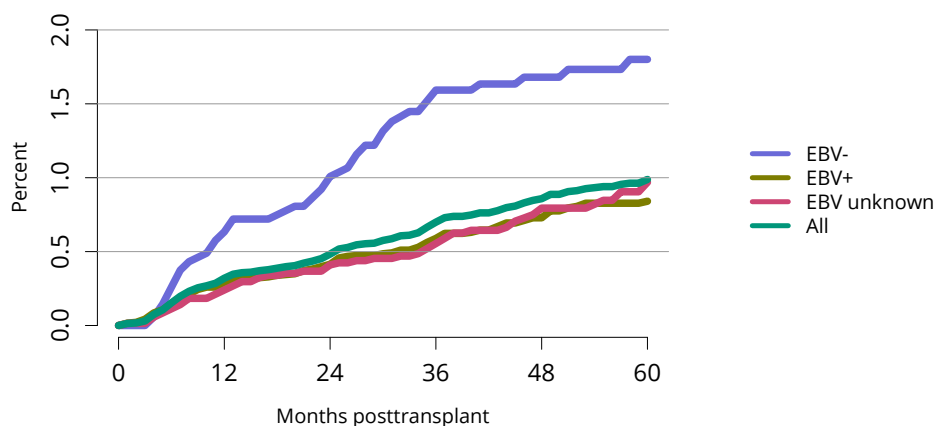


Figure LI 66. Incidence of PTLD among adult liver transplant recipients by recipient EBV status at transplant, 2010-2014. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. PTLD is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus; PTLD, posttransplant lymphoproliferative disorder.

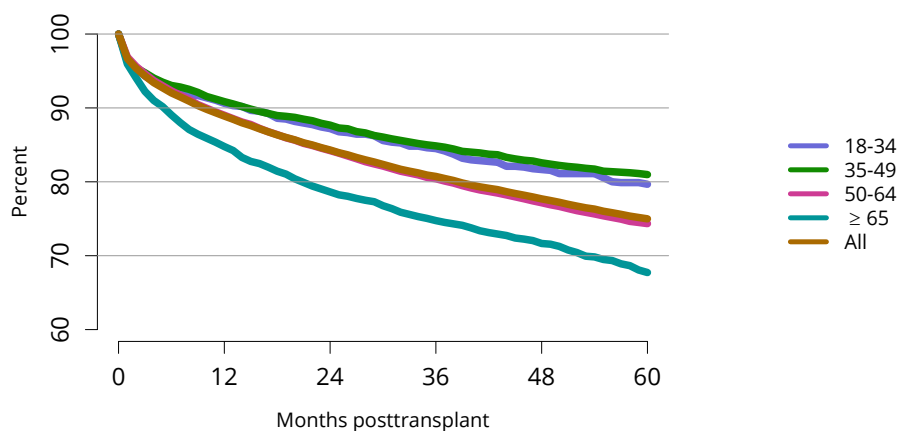


Figure LI 67. Patient survival among adult deceased donor liver transplant recipients, 2009-2011, by age. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

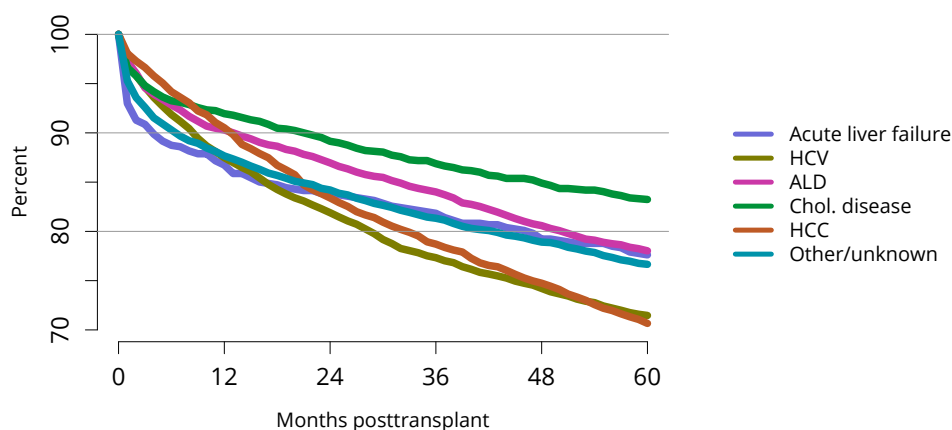


Figure LI 68. Patient survival among adult deceased donor liver transplant recipients, 2009-2011, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease.

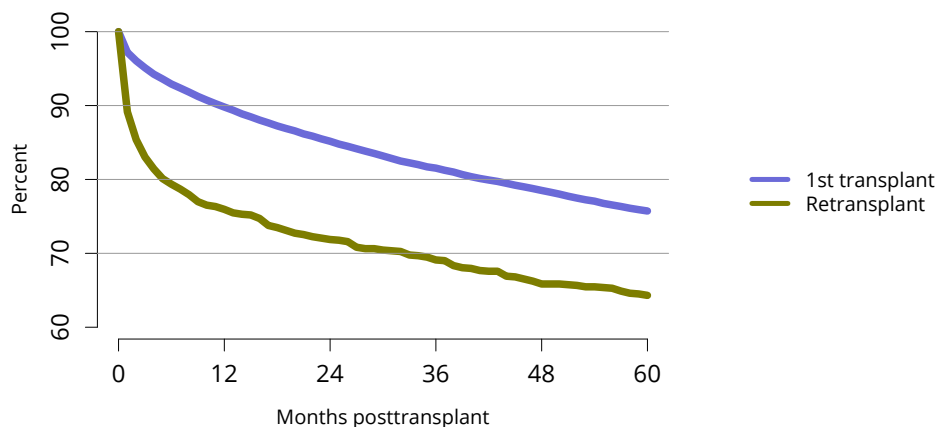


Figure LI 69. Patient survival among adult deceased donor liver transplant recipients, 2009-2011, by retransplant. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

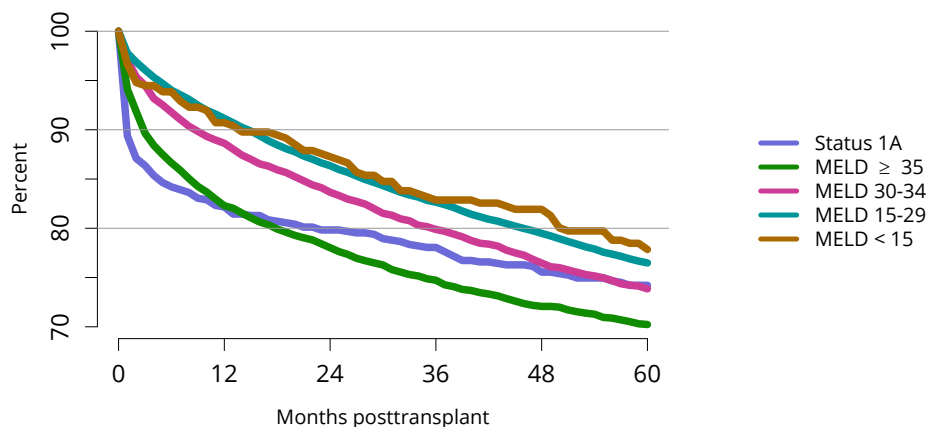


Figure LI 70. Patient survival among adult deceased donor liver transplant recipients, 2009-2011, by medical urgency. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

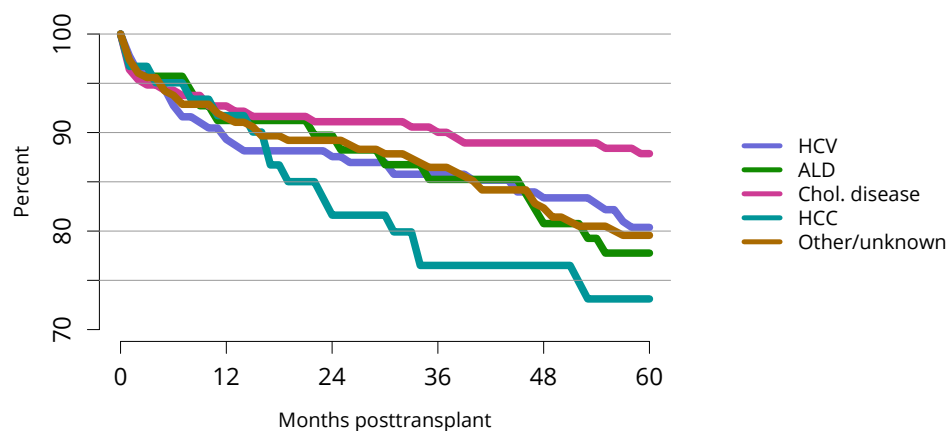


Figure LI 71. Patient survival among adult living donor liver transplant recipients, 2008-2011, by diagnosis. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered. HCV, hepatitis C virus; ALD, alcoholic liver disease; Chol. disease, cholestatic disease.

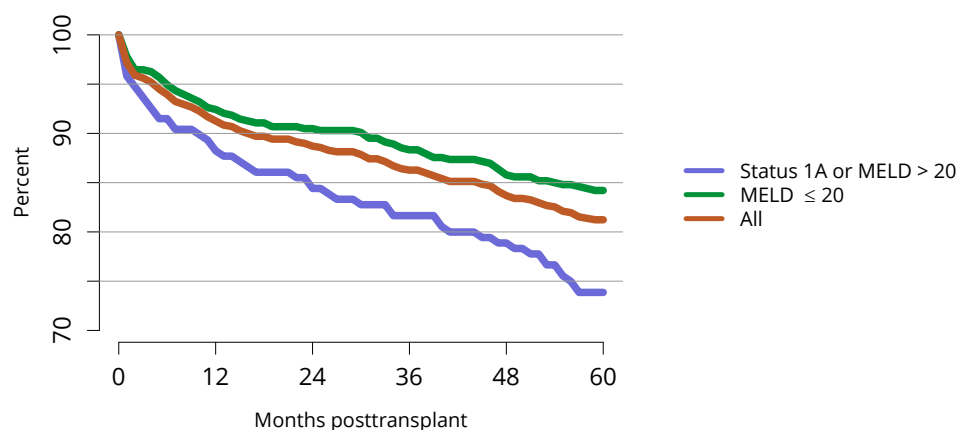


Figure LI 72. Patient survival among adult living donor liver transplant recipients, 2008-2011, by medical urgency. Patient survival estimated using unadjusted Kaplan-Meier methods. For recipients of more than one transplant during the period, only the first is considered.

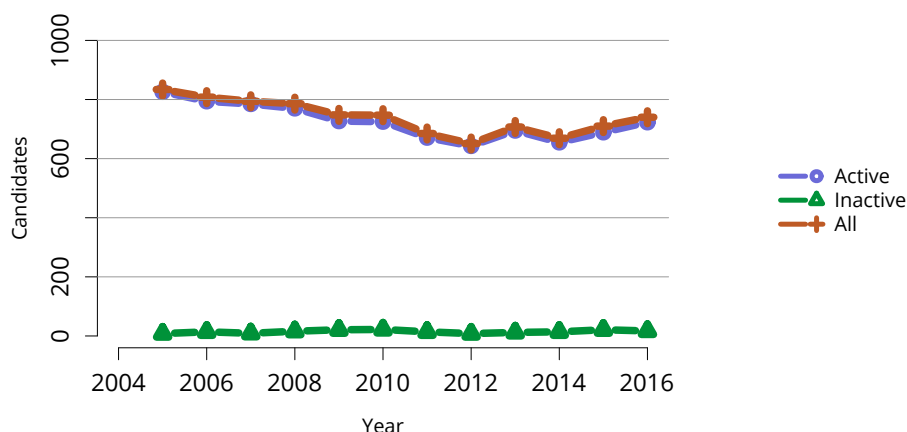


Figure LI 73. New pediatric candidates added to the liver transplant wait-list. A new candidate is one who first joined the list during the given year, without having been listed in a previous year. Previously listed candidates who underwent transplant and subsequently relisted are considered new. Candidates concurrently listed at multiple centers are counted once. Active and inactive patients are included. Age determined at listing.

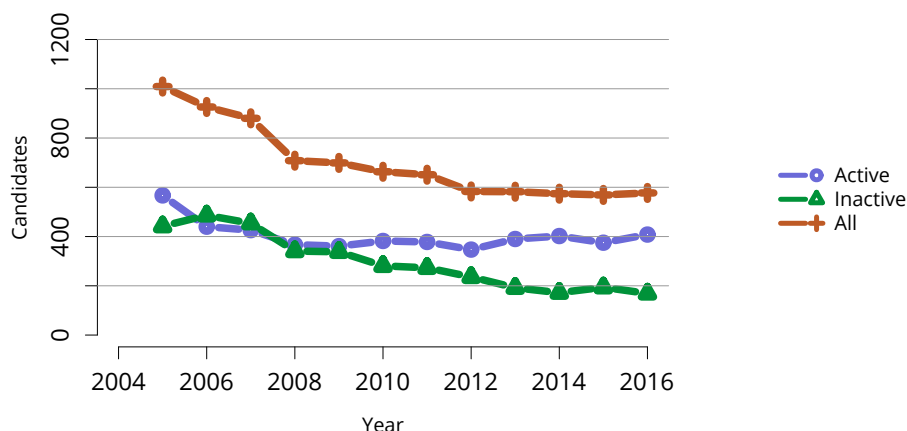


Figure LI 74. Pediatric candidates listed for liver transplant on December 31 each year. Candidates concurrently listed at multiple centers are counted once. Those with concurrent listings and active at any program are considered active.

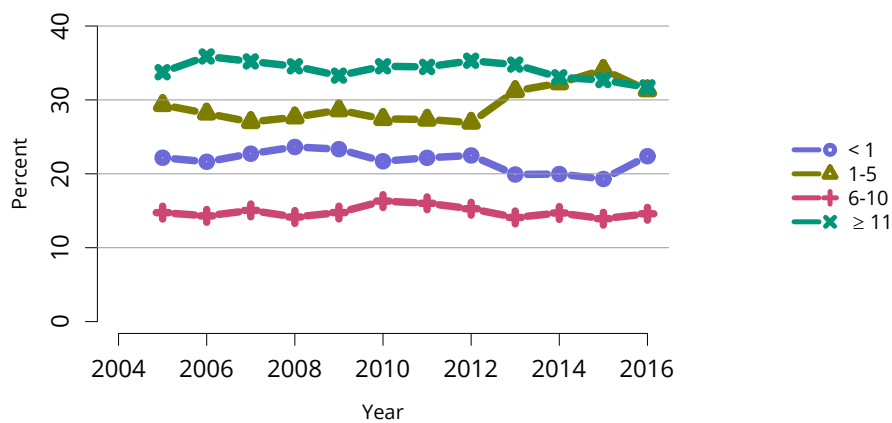


Figure LI 75. Distribution of pediatric candidates waiting for liver transplant by age. Candidates waiting for transplant at any time in the given year. Candidates listed concurrently at multiple centers are counted once. Age is determined at the later of listing date or January 1 of the given year. Active and inactive candidates are included.

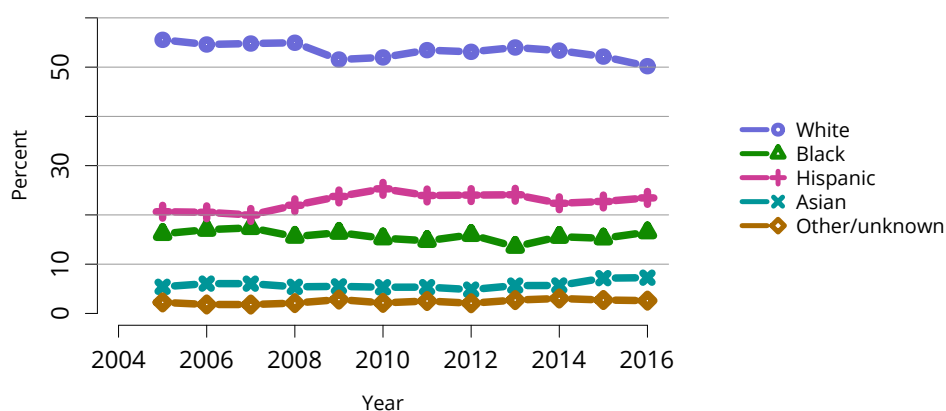


Figure LI 76. Distribution of pediatric candidates waiting for liver transplant by race. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Active and inactive candidates are included.

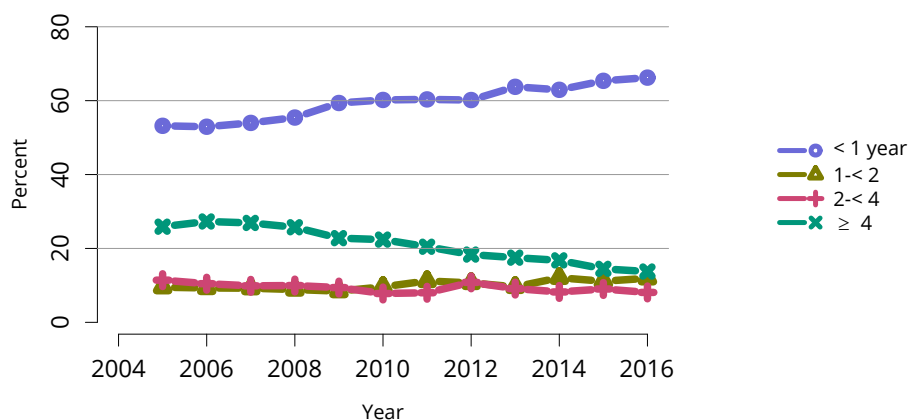


Figure LI 77. Distribution of pediatric candidates waiting for liver transplant by waiting time. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Time on the waiting list is determined at the earlier of December 31 or removal from the waiting list. Active and inactive candidates are included.

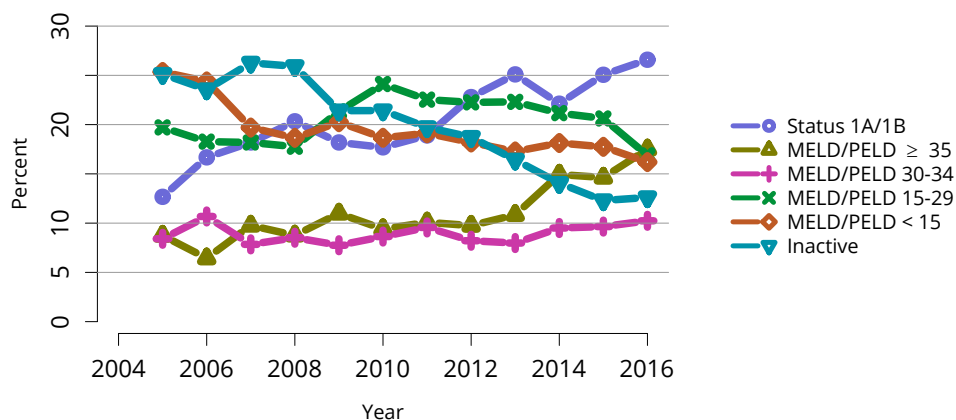


Figure LI 78. Distribution of pediatric candidates waiting for liver transplant by medical urgency. Candidates waiting for transplant any time in the given year. Candidates listed concurrently at multiple centers are counted once. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores. Medical urgency status is the most severe during the year. Active and inactive candidates are included.

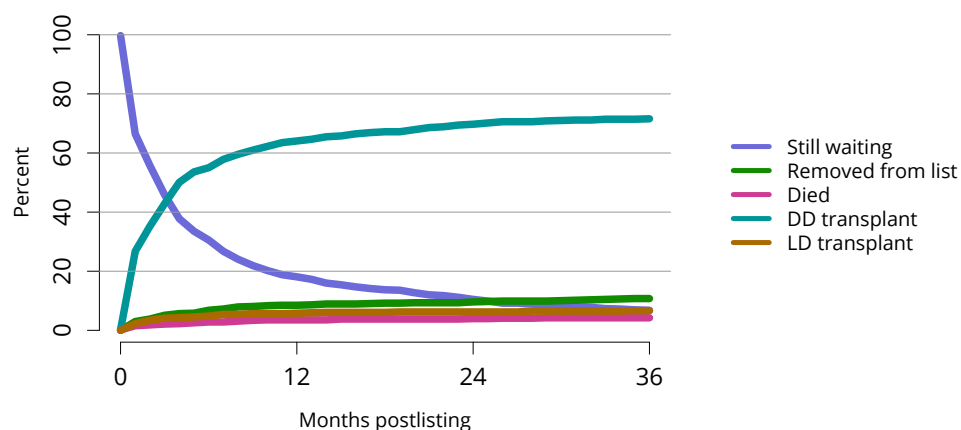


Figure LI 79. Three-year outcomes for newly listed pediatric candidates waiting for liver transplant, 2013. Pediatric candidates who joined the waitlist in 2013. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. DD, deceased donor; LD, living donor.

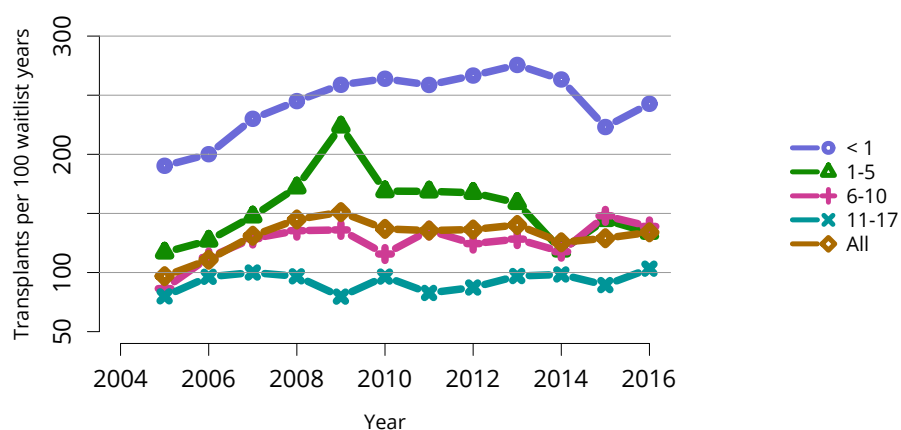


Figure LI 80. Deceased donor liver transplant rates among active pediatric waitlist candidates by age. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure are not shown.

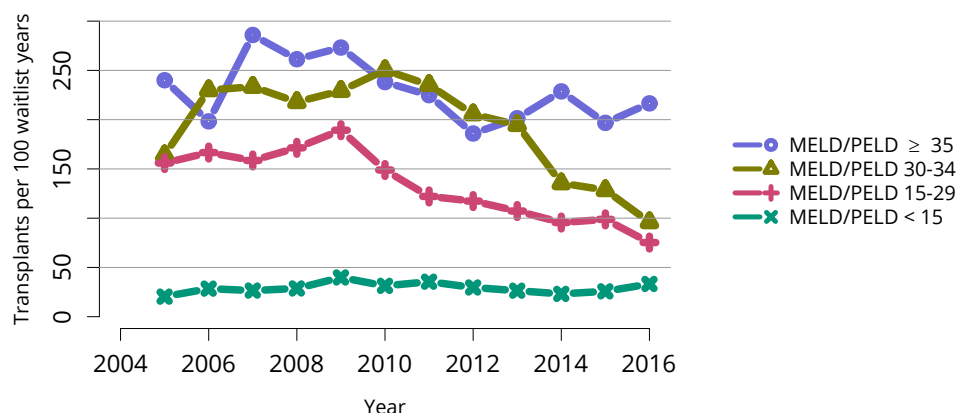


Figure LI 81. Deceased donor liver transplant rates among active pediatric waitlist candidates by medical urgency. Transplant rates are computed as the number of deceased donor transplants per 100 patient-years of active waiting in a given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores.

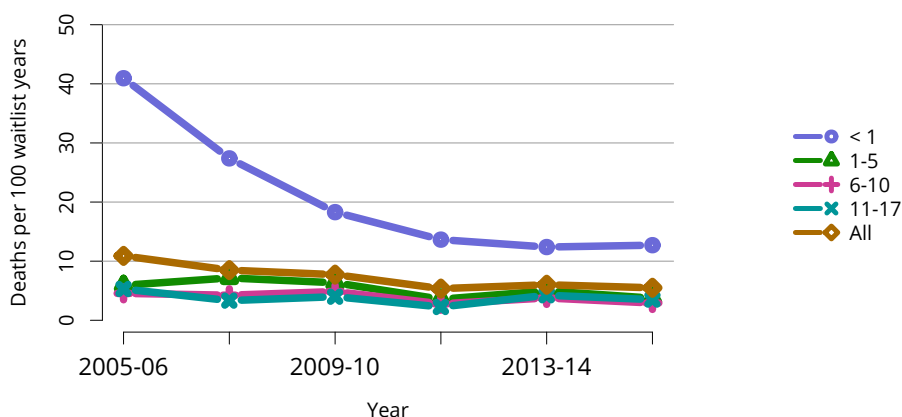


Figure LI 82. Pretransplant mortality rates among pediatric waitlisted for liver transplant by age. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Age is determined at the later of listing date or January 1 of the given year. Rates with less than 10 patient-years of exposure are not shown.

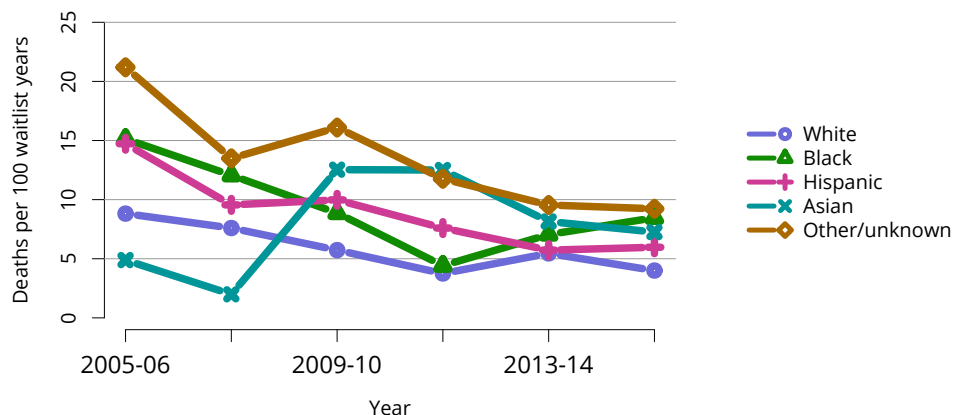


Figure LI 83. Pretransplant mortality rates among pediatric liver transplant waitlisted by race. Mortality rates are computed as the number of deaths per 100 patient-years of waiting in the given year. Individual listings are counted separately. Rates with less than 10 patient-years of exposure are not shown.

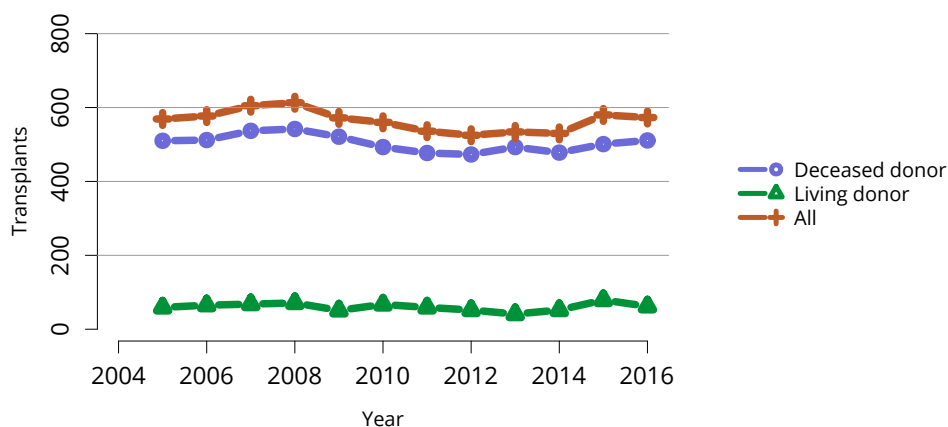


Figure LI 84. Pediatric liver transplants by donor type. All pediatric liver transplant recipients, including retransplant, and multi-organ recipients.

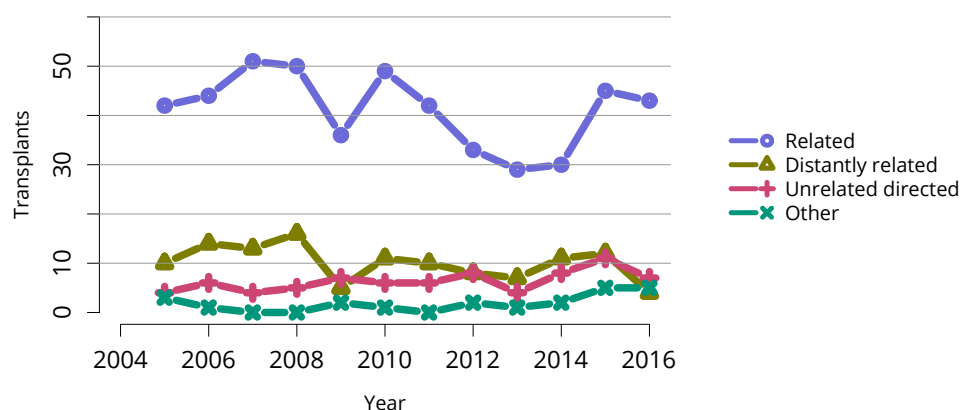


Figure LI 85. Pediatric liver transplants from living donors by relation. Relationship of living donor to recipient is as indicated on the OPTN Living Donor Registration Form.

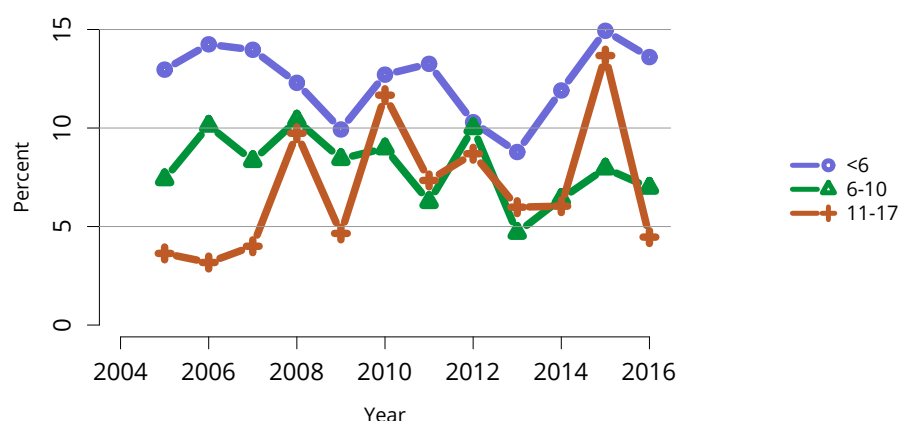


Figure LI 86. Percent of pediatric liver transplants from living donors by recipient age. All pediatric living liver transplant recipients, including retransplant, and multi-organ recipients.

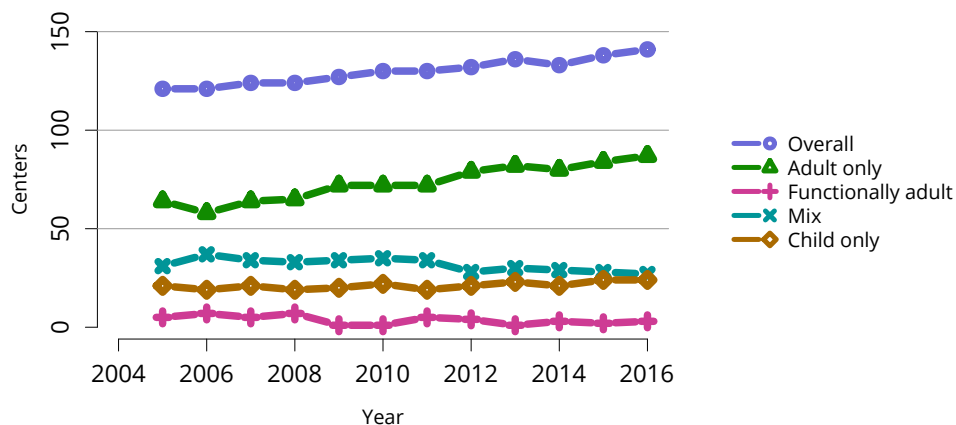


Figure LI 87. Number of centers performing pediatric and adult liver transplants by center's age mix. Adult centers transplanted only recipients aged 18 years or older. Functionally adult centers transplant 80% adults or more, and the remainder were children aged 15-17 years. Mixed included adults and children of any age groups. Child only centers transplanted recipients aged 0-17 years, and small number of adults up to age 21 years.

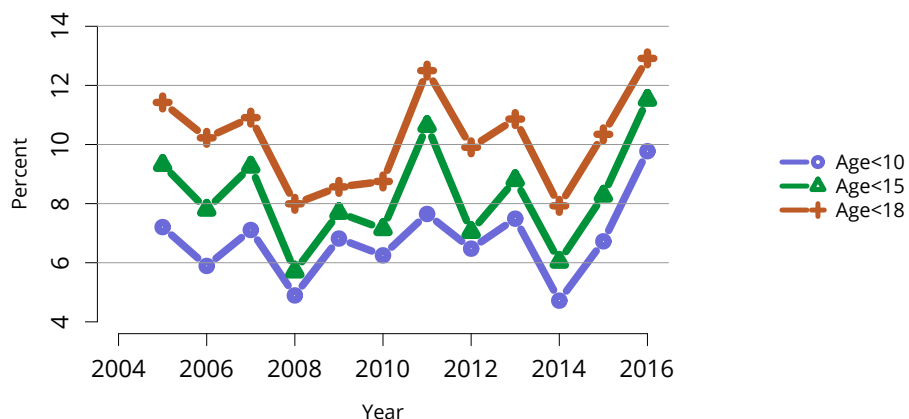


Figure LI 88. Pediatric liver recipients at programs that perform 5 or fewer pediatric transplants annually. Age groups are cumulative.

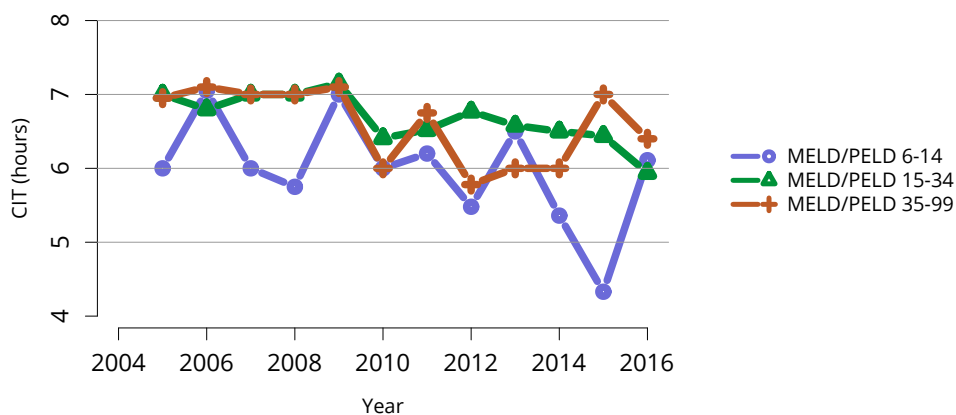


Figure LI 89. Donor liver cold ischemia among pediatric liver recipients by allocation MELD/PELD. NA

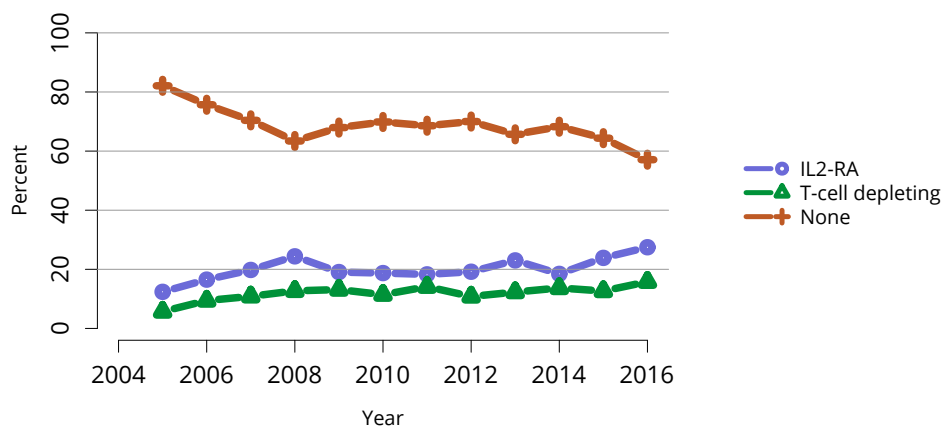


Figure LI 90. Induction agent use in pediatric liver transplant recipients. Immunosuppression at transplant reported to the OPTN. IL2-RA, interleukin-2 receptor antagonist.

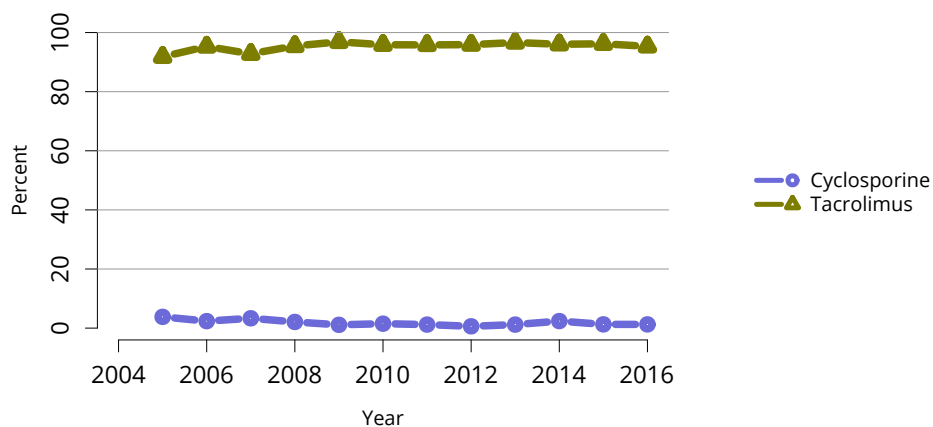


Figure LI 91. Calcineurin inhibitor use in pediatric liver transplant recipients. Immunosuppression at transplant reported to the OPTN.

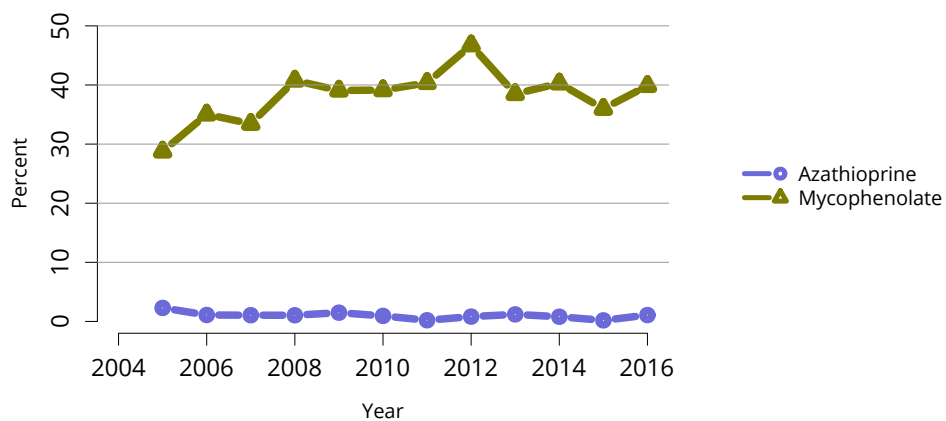


Figure LI 92. Anti-metabolite use in pediatric liver transplant recipients. Immunosuppression at transplant reported to the OPTN. Mycophenolate includes mycophenolate mofetil and mycophenolate sodium.

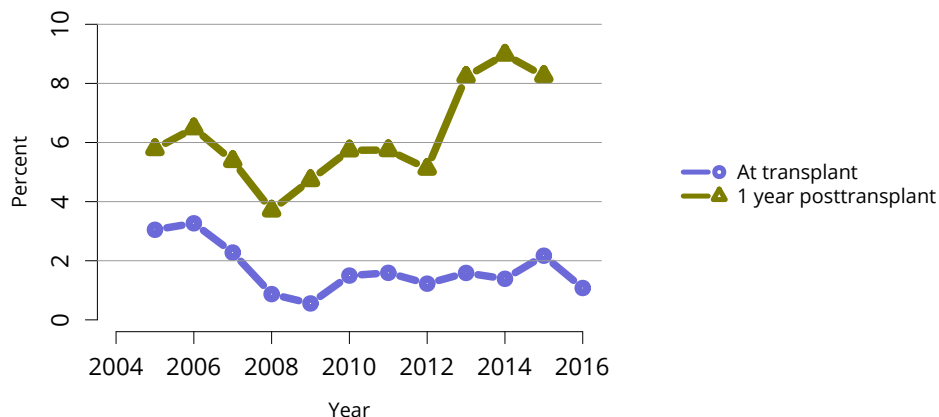


Figure LI 93. mTOR inhibitor use in pediatric liver transplant recipients. Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant. mTOR, mammalian target of rapamycin.

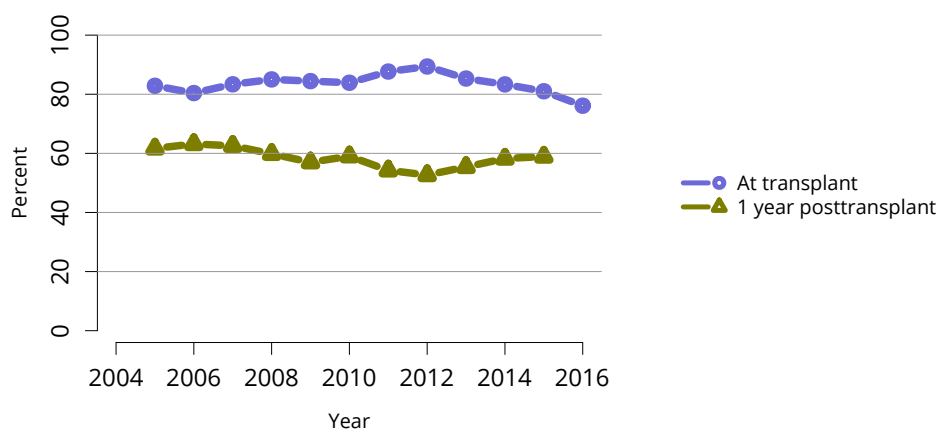


Figure LI 94. Steroid use in pediatric liver transplant recipients. Immunosuppression at transplant reported to the OPTN. One-year posttransplant data are limited to patients alive with graft function at 1 year posttransplant.

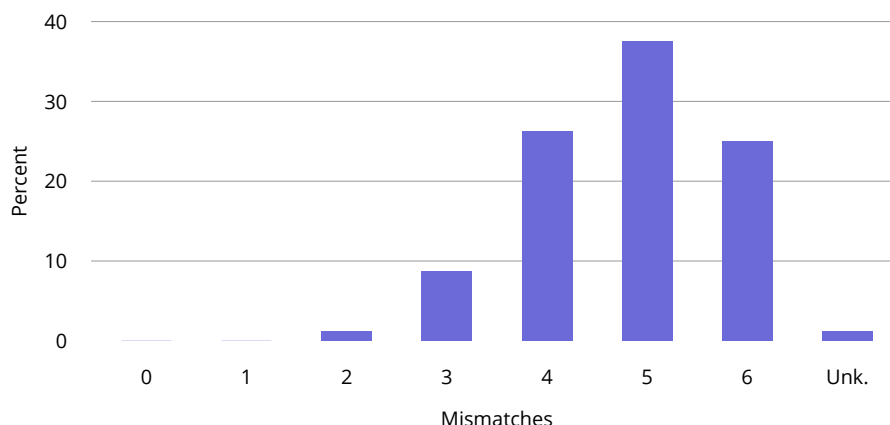


Figure LI 95. Total HLA A, B, and DR mismatches among pediatric deceased donor liver-kidney transplant recipients, 2012-2016. Donor and recipient antigen matching is based on OPTN antigen values and split equivalences policy as of 2016. Limited to deceased donor liver-kidney transplants only.

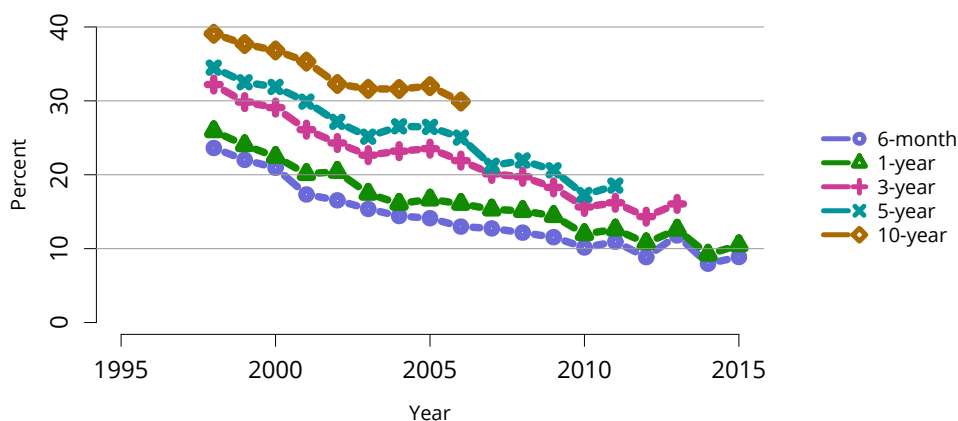


Figure LI 96. Graft failure among pediatric deceased donor liver transplant recipients. All pediatric recipients of deceased donor livers, including multi-organ transplants. Patients are followed until the earliest of retransplant, death, or December 31, 2016. Estimates computed with Cox proportional hazards models reporting, adjusted for age, sex, and race.

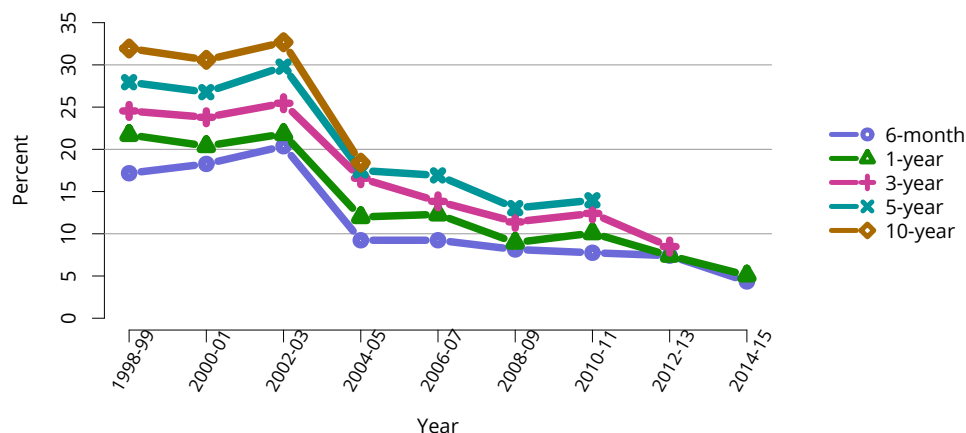


Figure LI 97. Graft failure among pediatric living donor liver transplant recipients. All pediatric recipients of living donor livers, including multi-organ transplants. Patients are followed until the earliest of retransplant, death, or December 31, 2016. Estimates computed with Cox proportional hazards models reporting, adjusted for age, sex, and race.

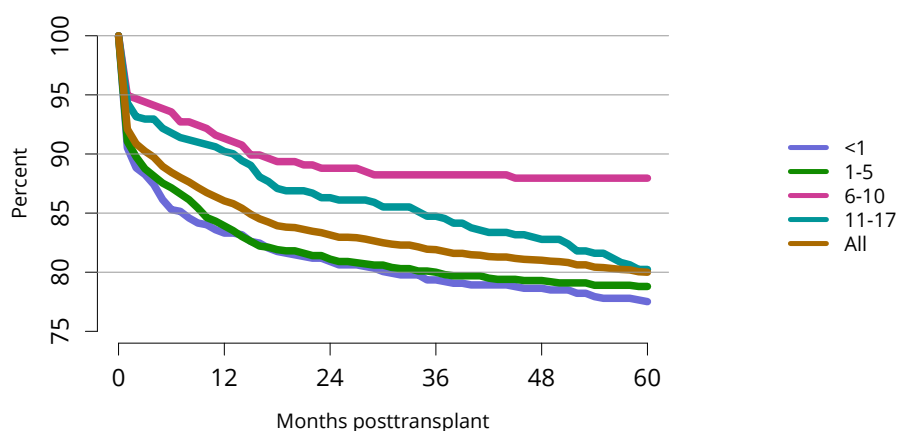


Figure LI 98. Graft survival among pediatric deceased donor liver transplant recipients, 2007-2011, by age. Graft survival estimated using unadjusted Kaplan-Meier methods.

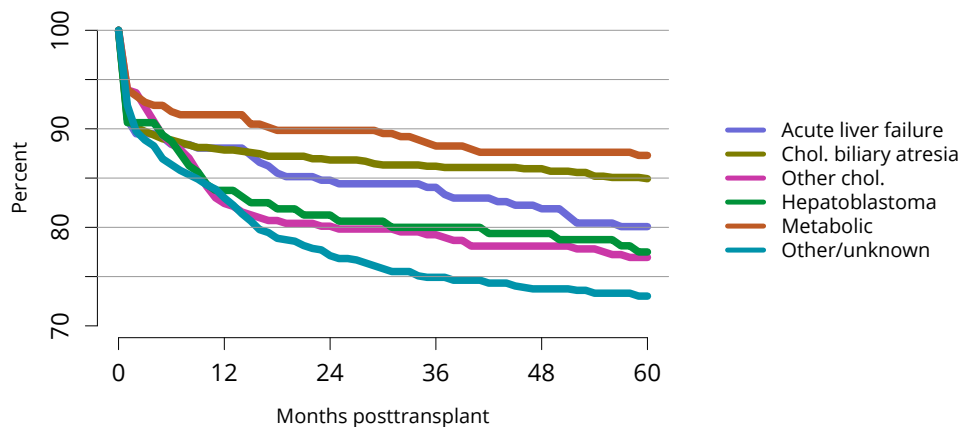


Figure LI 99. Graft survival among pediatric deceased donor liver transplant recipients, 2007-2011, by diagnosis. Graft survival estimated using unadjusted Kaplan-Meier methods. Chol. disease, cholestatic disease.

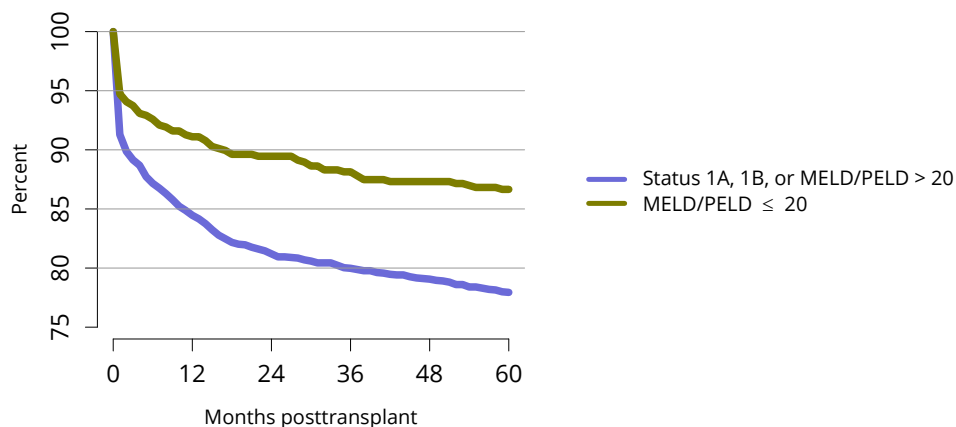


Figure LI 100. Graft survival among pediatric deceased donor liver transplant recipients, 2007-2011, by medical urgency. Graft survival estimated using unadjusted Kaplan-Meier methods. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores.

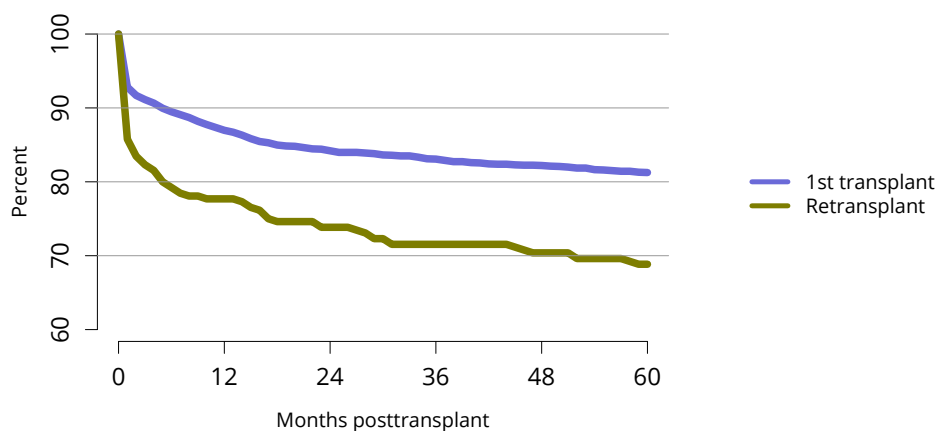


Figure LI 101. Graft survival among pediatric deceased donor liver transplant recipients, 2007-2011, by retransplant. Graft survival estimated using unadjusted Kaplan-Meier methods.

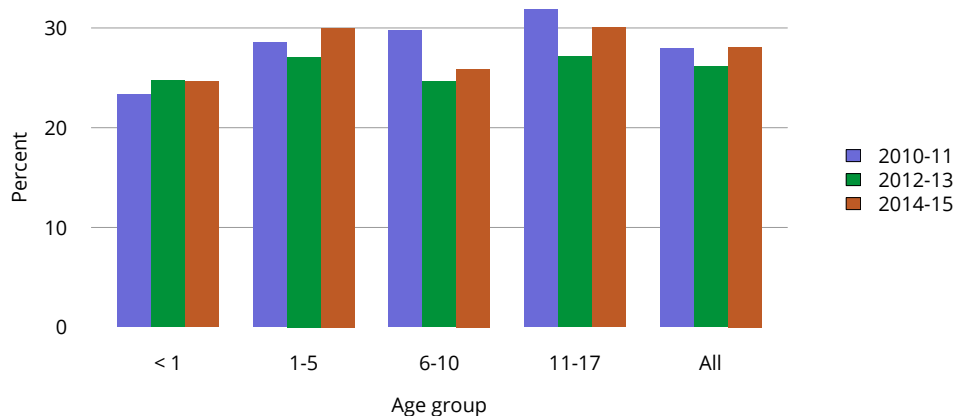


Figure LI 102. Incidence of acute rejection by 1 year posttransplant among pediatric liver transplant recipients by age. Acute rejection is defined as a record of acute or hyperacute rejection, as reported on the OPTN Transplant Recipient Registration Form or Transplant Recipient Follow-up Form. Only the first rejection event is counted. Cumulative incidence is estimated using the Kaplan-Meier competing risk method.

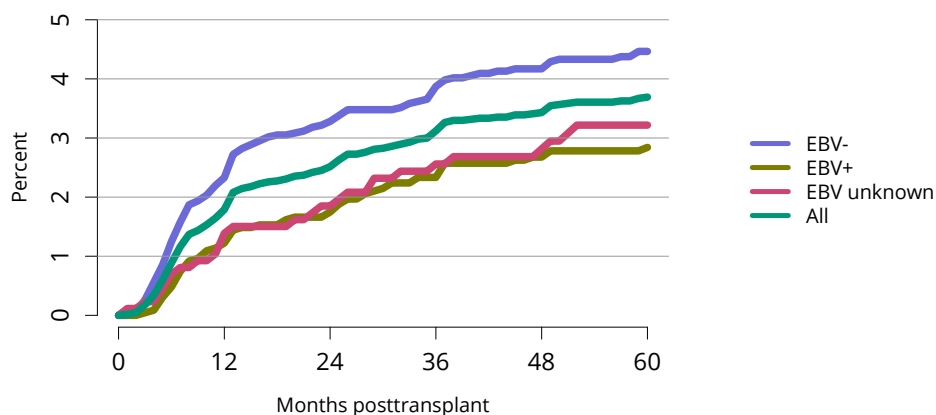


Figure LI 103. Incidence of PTLD among pediatric liver transplant recipients by recipient EBV status at transplant, 2004-2014. Cumulative incidence is estimated using the Kaplan-Meier competing risk method. Posttransplant lymphoproliferative disorder (PTLD) is identified as a reported complication or cause of death on the OPTN Transplant Recipient Follow-up Form or on the Posttransplant Malignancy Form as polymorphic PTLD, monomorphic PTLD, or Hodgkin disease. Only the earliest date of PTLD diagnosis is considered. EBV, Epstein-Barr virus.

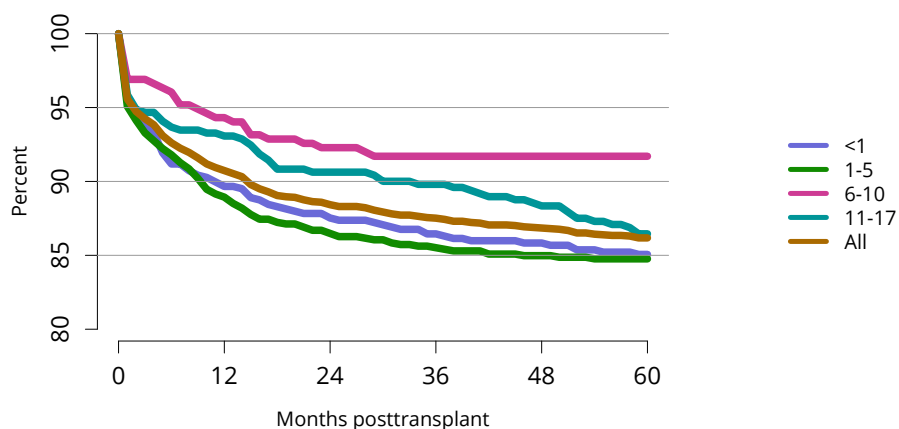


Figure LI 104. Patient survival among pediatric deceased donor liver transplant recipients, 2007-2011, by age. Recipient survival estimated using unadjusted Kaplan-Meier methods.

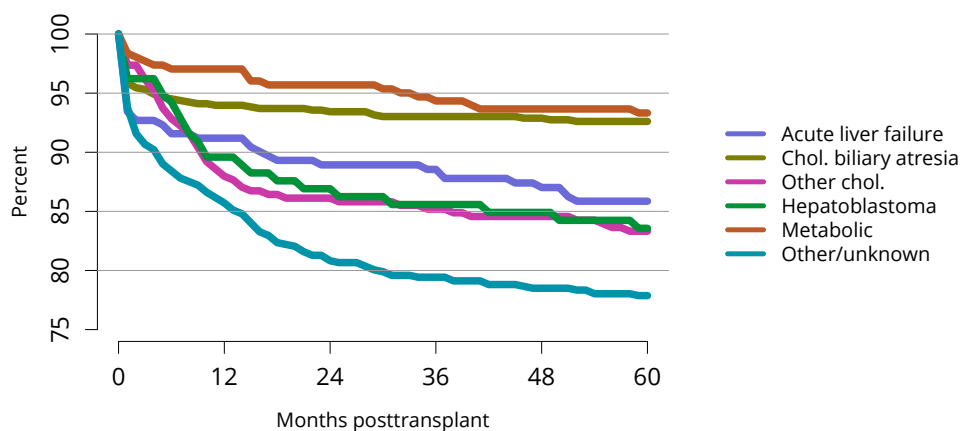


Figure LI 105. Patient survival among pediatric deceased donor liver transplant recipients, 2007-2011, by diagnosis. Recipient survival estimated using unadjusted Kaplan-Meier methods. Chol. disease, cholestatic disease.

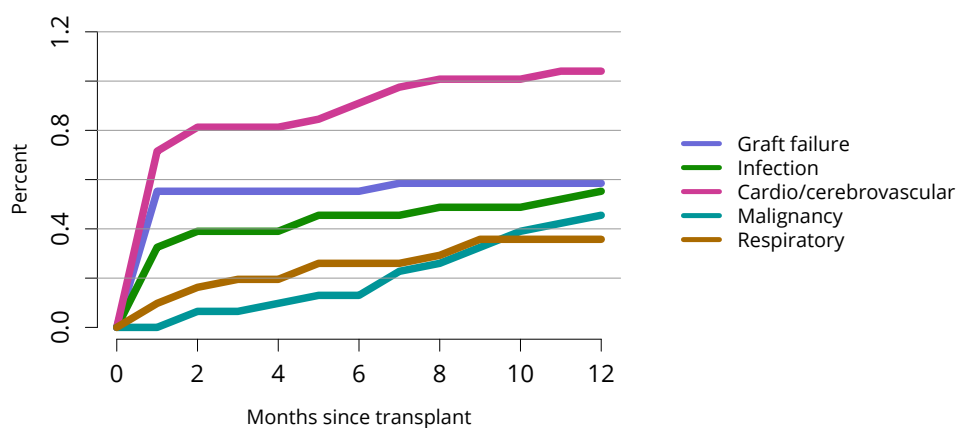


Figure LI 106. One-year cumulative incidence of death by cause among pediatric liver recipients, 2010-2015. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

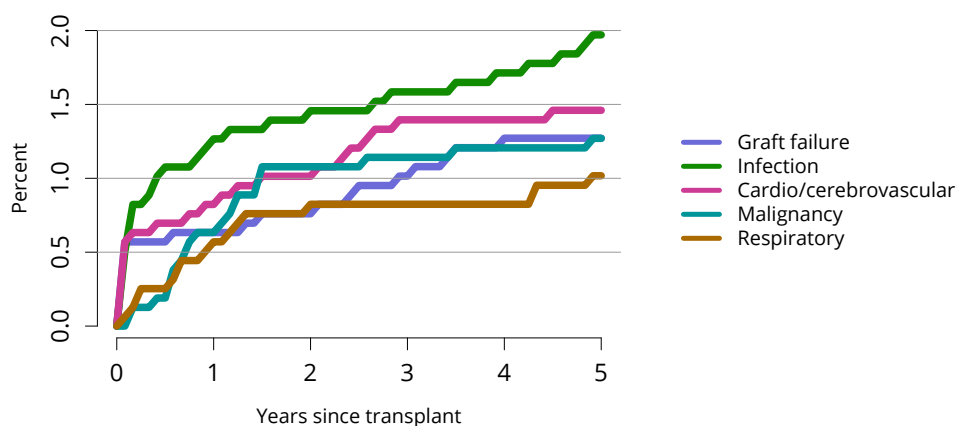


Figure LI 107. Five-year cumulative incidence of death by cause among pediatric liver recipients, 2009-2011. Primary cause of death is as reported on the OPTN Transplant Recipient Registration and Follow-up Forms. Other causes of death include hemorrhage, trauma, nonadherence, unspecified other, unknown, etc. Cumulative incidence is estimated using Kaplan-Meier competing risk methods.

Characteristic	2006		2016	
	N	Percent	N	Percent
Age				
18-34 years	621	4.0%	596	4.3%
35-49 years	3363	21.7%	2005	14.6%
50-64 years	9619	62.0%	7803	56.8%
≥ 65 years	1923	12.4%	3322	24.2%
Sex				
Female	6223	40.1%	5186	37.8%
Male	9303	59.9%	8540	62.2%
Race/ethnicity				
White	11,289	72.7%	9401	68.5%
Black	997	6.4%	1037	7.6%
Hispanic	2364	15.2%	2368	17.3%
Asian	755	4.9%	751	5.5%
Other/unknown	121	0.8%	169	1.2%
All candidates	15,526	100.0%	13,726	100.0%

Table LI 1 Demographic characteristics of adults on the liver transplant waiting list on December 31, 2006 and December 31, 2016. Candidates waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed.

Characteristic	2006		2016	
	N	Percent	N	Percent
Diagnosis				
Acute liver failure	551	3.5%	226	1.6%
HCV	4804	30.9%	3117	22.7%
Alcoholic liver disease	3633	23.4%	3712	27.0%
Cholestatic disease	1602	10.3%	1124	8.2%
HCC	295	1.9%	1130	8.2%
Other/unknown	4641	29.9%	4417	32.2%
Blood type				
A	5784	37.3%	5263	38.3%
B	1743	11.2%	1564	11.4%
AB	401	2.6%	355	2.6%
O	7598	48.9%	6544	47.7%
Medical urgency				
Status 1A	3	0.0%	1	0.0%
MELD \geq 35	28	0.2%	51	0.4%
MELD 30-34	24	0.2%	383	2.8%
MELD 15-29	2939	18.9%	4356	31.7%
MELD $<$ 15	9025	58.1%	6349	46.3%
Unknown	1	0.0%	0	0.0%
Inactive	3506	22.6%	2586	18.8%
Exception status				
None	14,965	96.4%	11,082	80.7%
HCC	407	2.6%	1918	14.0%
Other	154	1.0%	726	5.3%
All candidates	15,526	100.0%	13,726	100.0%

Table LI 2 Clinical characteristics of adults on the liver transplant waiting list on December 31, 2006 and December 31, 2016. Candidates waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed. HCC, hepatocellular carcinoma; HCV, hepatitis C virus.

Characteristic	2006		2016	
	N	Percent	N	Percent
Transplant history				
First	14,882	95.9%	13,375	97.4%
Retransplant	644	4.1%	351	2.6%
Wait time				
< 1 year	4549	29.3%	5793	42.2%
1-< 2 years	2463	15.9%	2387	17.4%
2-< 3 years	1950	12.6%	1521	11.1%
3-< 4 years	1569	10.1%	1035	7.5%
4-< 5 years	1157	7.5%	723	5.3%
≥ 5 years	3838	24.7%	2267	16.5%
Tx type				
Liver alone	15,152	97.6%	12,737	92.8%
Liver-kidney	326	2.1%	910	6.6%
Liver-pancreas-intestine	19	0.1%	29	0.2%
Liver-heart	10	0.1%	30	0.2%
Other	19	0.1%	20	0.1%
All candidates	15,526	100.0%	13,726	100.0%

Table LI 3 Listing characteristics of adults on the liver transplant waiting list on December 31, 2006 and December 31, 2016. Candidates waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed.

Waiting list state	2014	2015	2016
Patients at start of year	15,021	14,625	14,039
Patients added during year	10,646	10,636	11,340
Patients removed during year	11,014	11,208	11,653
Patients at end of year	14,653	14,053	13,726

Table LI 4 Liver transplant waitlist activity among adults. Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multi-organ transplants are included.

Removal reason	2014	2015	2016
Deceased donor transplant	5876	6193	6903
Living donor transplant	228	278	283
Transplant outside US	10	2	5
Patient died	1834	1686	1399
Patient refused transplant	103	92	121
Improved, transplant not needed	690	776	763
Too sick for transplant	1285	1219	1205
Other	988	962	974

Table LI 5 Removal reason among adult liver transplant candidates. Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Level	N	Pct
Biliary complication: Yes	54	3.8%
Biliary complication: No	1368	95.9%
Biliary complication: Unknown	5	0.4%
Clavien Grade: 1	15	1.1%
Clavien Grade: 2	34	2.4%
Clavien Grade: 3	9	0.6%
Vascular complication, requiring intervention: Yes	17	1.2%
Vascular complication, requiring intervention: No	1405	98.5%
Vascular complication, requiring intervention: Unknown	5	0.4%
Other complication, requiring intervention: Yes	107	7.5%
Other complication, requiring intervention: No	1310	91.8%
Other complication, requiring intervention: Unknown	10	0.7%
Re-operation: Yes	31	2.2%
Re-operation: No	1391	97.5%
Re-operation: Unknown	5	0.4%

Table LI 6 Complications among living liver donors, 2012-2016. Complications reported on the OPTN Living Donor Registration Form. Clavien Grade 1, bilious Jackson Pratt drainage more than 10 days; Clavien Grade 2, interventional procedure (endoscopic retrograde cholangiopancreatography, percutaneous transhepatic cholangiography, percutaneous drainage, etc.); Clavien Grade 3, surgical intervention. Clavient grades refer to biliary complications. Domino liver donors excluded.

Cause	0-30 days	31-90 days	91-365 days
Suicide	0	0	0
Accident/homicide	0	0	0
Medical	1	0	0
Cancer	0	0	0
Unknown	0	0	0
TOTAL	1	0	0

Table LI 7 Living liver donor deaths, 2012-2016, by number of days after donation. Living liver donors, excluding domino livers. Numbers of deaths reported to OPTN or the Social Security Administration. No deaths occurred within a year of donation among living liver donors, 2011-2015.

Characteristic	2006		2016	
	N	Percent	N	Percent
Age				
18-34 years	382	6.3%	459	6.3%
35-49 years	1458	24.0%	1228	16.9%
50-64 years	3605	59.4%	4117	56.6%
≥ 65 years	629	10.4%	1464	20.1%
Sex				
Female	2003	33.0%	2509	34.5%
Male	4071	67.0%	4759	65.5%
Race/ethnicity				
White	4370	71.9%	5129	70.6%
Black	610	10.0%	652	9.0%
Hispanic	785	12.9%	1072	14.7%
Asian	255	4.2%	317	4.4%
Other/unknown	54	0.9%	98	1.3%
BMI				
< 18.5 kg/m ²	154	2.5%	136	1.9%
18.5-< 25 kg/m ²	1846	30.4%	2001	27.5%
25-< 28 kg/m ²	1321	21.7%	1504	20.7%
28-< 30 kg/m ²	826	13.6%	916	12.6%
30-< 35 kg/m ²	1253	20.6%	1637	22.5%
≥ 35 kg/m ²	670	11.0%	1072	14.7%
Unknown	4	0.1%	2	0.0%
Insurance				
Private	3665	60.3%	3707	51.0%
Medicare	1228	20.2%	2158	29.7%
Medicaid	902	14.9%	1008	13.9%
Unknown	279	4.6%	395	5.4%
All recipients	6074	100.0%	7268	100.0%

Table LI 8 Demographic characteristics of adult liver transplant recipients, 2006 and 2016. Adult liver transplant recipients, including retransplants.

Characteristic	2006		2016	
	N	Percent	N	Percent
Diagnosis				
Acute liver failure	307	5.1%	226	3.1%
HCV	1530	25.2%	1276	17.6%
Alcoholic liver disease	1209	19.9%	1764	24.3%
Cholestatic disease	600	9.9%	672	9.2%
HCC	791	13.0%	1045	14.4%
Other/unknown	1637	27.0%	2285	31.4%
Blood type				
A	2286	37.6%	2683	36.9%
B	777	12.8%	1015	14.0%
AB	322	5.3%	337	4.6%
O	2689	44.3%	3233	44.5%
Medical condition				
Hospitalized in ICU	747	12.3%	1040	14.3%
Hospitalized, not ICU	959	15.8%	1383	19.0%
Not hospitalized	4368	71.9%	4760	65.5%
Hospitalization unknown	0	0.0%	85	1.2%
Medical urgency				
Status 1A	304	5.0%	185	2.5%
MELD \geq 35	615	10.1%	1667	22.9%
MELD 30-34	479	7.9%	1342	18.5%
MELD 15-29	4194	69.0%	3770	51.9%
MELD $<$ 15	479	7.9%	301	4.1%
Unknown	3	0.0%	3	0.0%
HCC exception	1145	18.9%	1488	20.5%
Other MELD exception	430	7.1%	882	12.1%
Diabetes	1430	23.5%	2090	28.8%
All recipients	6074	100.0%	7268	100.0%

Table LI 9 Clinical characteristics of adult liver transplant recipients, 2006 and 2016. Adult liver transplant recipients, including retransplants. HCC, hepatocellular carcinoma; HCV, hepatitis C virus.

Characteristic	2006		2016	
	N	Percent	N	Percent
Wait time				
< 31 days	2281	37.6%	2398	33.0%
31-60 days	750	12.3%	679	9.3%
61-90 days	438	7.2%	435	6.0%
3-< 6 months	875	14.4%	847	11.7%
6-< 12 months	698	11.5%	1376	18.9%
1-< 2 years	496	8.2%	965	13.3%
2-< 3 years	193	3.2%	242	3.3%
≥ 3 years	342	5.6%	326	4.5%
Unknown	1	0.0%	0	0.0%
Donor type				
Deceased	5851	96.3%	6985	96.1%
Living	223	3.7%	283	3.9%
Procedure				
Whole liver	5801	95.5%	6901	95.0%
Partial liver	217	3.6%	278	3.8%
Split liver	56	0.9%	89	1.2%
DCD status				
DBD	5792	95.4%	6823	93.9%
DCD	282	4.6%	445	6.1%
Tx type				
Liver only	5636	92.8%	6491	89.3%
Liver-kidney	395	6.5%	717	9.9%
Other	43	0.7%	60	0.8%
Transplant history				
First	5573	91.8%	6952	95.7%
Retransplant	501	8.2%	316	4.3%
All recipients	6074	100.0%	7268	100.0%

Table LI 10 Transplant characteristics of adult liver transplant recipients, 2006 and 2016. Adult liver transplant recipients, including retransplants. DBD, donation after brain death; DCD, donation after circulatory death.

Donor	Recipient	CMV	EBV	HB core	HB surf. ant.	HCV	HIV
D-	R-	6.9%	0.5%	73.4%	93.0%	59.7%	94.3%
D-	R+	13.7%	3.8%	17.6%	4.0%	32.4%	0.5%
D-	R unk	15.5%	1.3%	4.0%	2.9%	2.3%	3.9%
D+	R-	11.5%	10.4%	3.3%	0.0%	0.2%	0.0%
D+	R+	25.0%	65.1%	1.6%	0.0%	5.2%	0.0%
D+	R unk	27.1%	18.9%	0.1%	0.0%	0.1%	0.0%
D unk	R-	0.1%	0.0%	0.0%	0.1%	0.0%	1.3%
D unk	R+	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%
D unk	R unk	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%

Table LI 11 Adult deceased donor liver donor-recipient serology matching, 2012-2016. Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. Any evidence for a positive serology is treated as positive for that serology. If all fields are unknown, incomplete, or pending, the person is categorized as unknown for that serology; otherwise, serology is assumed negative. CMV, cytomegalovirus; EBV, Epstein-Barr virus; HB, hepatitis B; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

Donor	Recipient	CMV	EBV	HB core	HB surf. ant.	HCV	HIV
D-	R-	14.1%	1.7%	78.4%	86.9%	68.0%	48.4%
D-	R+	13.6%	9.6%	10.6%	2.3%	24.2%	0.2%
D-	R unk	23.8%	2.7%	2.8%	4.1%	2.8%	1.5%
D+	R-	7.8%	6.9%	0.8%	0.3%	0.5%	0.0%
D+	R+	15.2%	58.7%	0.8%	0.1%	0.1%	0.0%
D+	R unk	21.3%	5.1%	0.0%	0.1%	0.0%	0.0%
D unk	R-	1.3%	0.8%	4.3%	5.4%	3.0%	47.0%
D unk	R+	1.9%	2.8%	0.6%	0.1%	0.8%	0.2%
D unk	R unk	0.8%	11.8%	1.6%	0.8%	0.7%	2.8%

Table LI 12 Adult living donor liver donor-recipient serology matching, 2012-2016. Donor serology is reported on the OPTN Donor Registration Form and recipient serology on the OPTN Transplant Recipient Registration Form. There may be multiple fields per serology. Any evidence for a positive serology is treated as positive for that serology. If all fields are unknown, incomplete, or pending, the person is categorized as unknown for that serology; otherwise, serology is assumed negative. CMV, cytomegalovirus; EBV, Epstein-Barr virus; HB, hepatitis B; HCV, hepatitis C virus; HIV, human immunodeficiency virus.

Characteristic	2006		2016	
	N	Percent	N	Percent
Age				
< 1 year	65	9.0%	53	10.9%
1-5 years	250	34.6%	191	39.4%
6-10 years	174	24.1%	96	19.8%
11-17 years	234	32.4%	145	29.9%
Sex				
Female	386	53.4%	244	50.3%
Male	337	46.6%	241	49.7%
Race/ethnicity				
White	395	54.6%	240	49.5%
Black	123	17.0%	77	15.9%
Hispanic	140	19.4%	122	25.2%
Asian	54	7.5%	32	6.6%
Other/unknown	11	1.5%	14	2.9%
All candidates	723	100.0%	485	100.0%

Table LI 13 Demographic characteristics of pediatric candidates on the liver transplant waiting list on December 31, 2006, December 31, 2011, and December 31, 2016. Candidates aged younger than 18 years waiting for transplant on December 31 of given year, regardless of first listing date; multiple listings are collapsed. Age calculated at snapshot.

Characteristic	2006		2016	
	N	Percent	N	Percent
Diagnosis				
Acute liver failure	44	6.1%	20	4.1%
Cholestatic biliary atresia	256	35.4%	151	31.1%
Other cholestatic	96	13.3%	58	12.0%
Hepatoblastoma	8	1.1%	12	2.5%
Metabolic	59	8.2%	71	14.6%
Other/unknown	260	36.0%	173	35.7%
Blood type				
A	220	30.4%	125	25.8%
B	91	12.6%	70	14.4%
AB	14	1.9%	10	2.1%
O	398	55.0%	280	57.7%
Medical urgency				
Status 1A/1B	6	0.8%	31	6.4%
MELD/PELD \geq 35	23	3.2%	66	13.6%
MELD/PELD 30-34	47	6.5%	55	11.3%
MELD/PELD 15-29	100	13.8%	89	18.4%
MELD/PELD $<$ 15	183	25.3%	115	23.7%
Inactive	364	50.3%	129	26.6%
Exception status				
None	654	90.5%	336	69.3%
Granted	69	9.5%	149	30.7%
All candidates	723	100.0%	485	100.0%

Table LI 14 Clinical characteristics of pediatric candidates on the liver transplant waiting list on December 31, 2006, December 31, 2011, and December 31, 2016. Candidates aged younger than 18 years waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores.

Characteristic	2006		2016	
	N	Percent	N	Percent
Transplant history				
First	632	87.4%	433	89.3%
Retransplant	91	12.6%	52	10.7%
Wait time				
< 1 year	260	36.0%	271	55.9%
1-< 2 years	102	14.1%	80	16.5%
2-< 3 years	68	9.4%	34	7.0%
3-< 4 years	43	5.9%	32	6.6%
4-< 5 years	40	5.5%	17	3.5%
≥ 5 years	210	29.0%	51	10.5%
Tx type				
Liver alone	613	84.8%	388	80.0%
Liver-kidney	12	1.7%	21	4.3%
Liver-pancreas-intestine	49	6.8%	69	14.2%
Liver-heart	1	0.1%	0	0.0%
Other	48	6.6%	7	1.4%
All candidates	723	100.0%	485	100.0%

Table LI 15 Listing characteristics of pediatric candidates on the liver transplant waiting list on December 31, 2006, December 31, 2011, and December 31, 2016. Candidates aged younger than 18 years waiting for transplant on December 31, 2006, and December 31, 2016, regardless of first listing date; multiple listings are collapsed.

Waiting list state	2014	2015	2016
Patients at start of year	583	575	567
Patients added during year	669	710	740
Patients removed during year	677	716	730
Patients at end of year	575	569	577

Table LI 16 Liver transplant waitlist activity among pediatric candidates.

Candidates concurrently listed at more than one center are counted once, from the time of earliest listing to the time of latest removal. Candidates who are listed, undergo transplant, and are relisted are counted more than once. Candidates are not considered to be on the list on the day they are removed; counts on January 1 may differ from counts on December 31 of the prior year. Candidates listed for multi-organ transplants are included.

Removal reason	2014	2015	2016
Deceased donor transplant	484	502	516
Living donor transplant	52	80	60
Transplant outside US	0	0	0
Patient died	34	30	34
Patient refused transplant	1	2	2
Improved, transplant not needed	68	63	58
Too sick for transplant	17	23	21
Other	21	16	39

Table LI 17 Removal reason among pediatric liver transplant candidates.
Removal reason as reported to the OPTN. Candidates with death dates that precede removal dates are assumed to have died waiting.

Characteristic	2004-06		2014-16	
	N	Percent	N	Percent
Age				
< 1 year	497	28.8%	416	24.7%
1-5 years	620	35.9%	670	39.8%
6-10 years	235	13.6%	252	15.0%
11-17 years	374	21.7%	345	20.5%
Sex				
Female	878	50.9%	848	50.4%
Male	848	49.1%	835	49.6%
Race/ethnicity				
White	931	53.9%	870	51.7%
Black	287	16.6%	267	15.9%
Hispanic	372	21.6%	370	22.0%
Asian	92	5.3%	126	7.5%
Other/unknown	44	2.5%	50	3.0%
Insurance				
Private	859	49.8%	670	39.8%
Medicare	17	1.0%	16	1.0%
Medicaid	695	40.3%	801	47.6%
Other government	110	6.4%	113	6.7%
Unknown	45	2.6%	83	4.9%
All recipients	1726	100.0%	1683	100.0%

Table LI 18 Demographic characteristics of pediatric liver transplant recipients, 2004-2006 and 2014-2016. Liver transplant recipients, including re-transplants. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores.

Characteristic	2004-06		2014-16	
	N	Percent	N	Percent
Diagnosis				
Acute liver failure	213	12.3%	157	9.3%
Cholestatic biliary atresia	505	29.3%	544	32.3%
Other cholestatic	219	12.7%	221	13.1%
Hepatoblastoma	88	5.1%	125	7.4%
Metabolic	178	10.3%	272	16.2%
Other/unknown	523	30.3%	364	21.6%
Blood type				
A	582	33.7%	553	32.9%
B	209	12.1%	232	13.8%
AB	70	4.1%	70	4.2%
O	865	50.1%	828	49.2%
Medical condition				
Hospitalized in ICU	484	28.0%	307	18.2%
Hospitalized, not ICU	274	15.9%	293	17.4%
Not hospitalized	968	56.1%	1073	63.8%
Hospitalization unknown	0	0.0%	10	0.6%
Medical urgency				
Status 1A/1B	573	33.2%	590	35.1%
MELD/PELD ≥ 35	168	9.7%	393	23.4%
MELD/PELD 30-34	192	11.1%	181	10.8%
MELD/PELD 15-29	471	27.3%	339	20.1%
MELD/PELD < 15	315	18.3%	178	10.6%
Unknown	7	0.4%	2	0.1%
Any MELD/PELD exception	419	24.3%	673	40.0%
All recipients	1726	100.0%	1683	100.0%

Table LI 19 Clinical characteristics of pediatric liver transplant recipients, 2004-2006 and 2014-2016. Liver transplant recipients, including retransplants. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores.

Characteristic	2004-06		2014-16	
	N	Percent	N	Percent
Wait time				
< 31 days	688	39.9%	538	32.0%
31-60 days	232	13.4%	279	16.6%
61-90 days	176	10.2%	168	10.0%
3-< 6 months	290	16.8%	303	18.0%
6-< 12 months	187	10.8%	206	12.2%
1-< 2 years	85	4.9%	127	7.5%
2-< 3 years	20	1.2%	29	1.7%
≥ 3 years	42	2.4%	33	2.0%
Unknown	6	0.3%	0	0.0%
ABO				
Compatible/identical	1688	97.8%	1602	95.2%
Incompatible	38	2.2%	81	4.8%
Donor type				
Deceased	1552	89.9%	1490	88.5%
Living	174	10.1%	193	11.5%
Procedure				
Whole liver	1144	66.3%	1069	63.5%
Partial liver	347	20.1%	371	22.0%
Split liver	235	13.6%	243	14.4%
DCD status				
DBD	1712	99.2%	1677	99.6%
DCD	14	0.8%	6	0.4%
Tx type				
Liver only	1494	86.6%	1520	90.3%
Liver-kidney	26	1.5%	43	2.6%
Other	206	11.9%	120	7.1%
Transplant history				
First	1537	89.0%	1538	91.4%
Retransplant	189	11.0%	145	8.6%
All recipients	1726	100.0%	1683	100.0%

Table LI 20 Transplant characteristics of pediatric liver transplant recipients, 2004-2006 and 2014-2016. Liver transplant recipients, including retransplants. Pediatric candidates aged 12 to 17 years can be assigned MELD or PELD scores. DBD, donation after brain death; DCD, donation after circulatory death.